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WARMTH AND VENTILATION.

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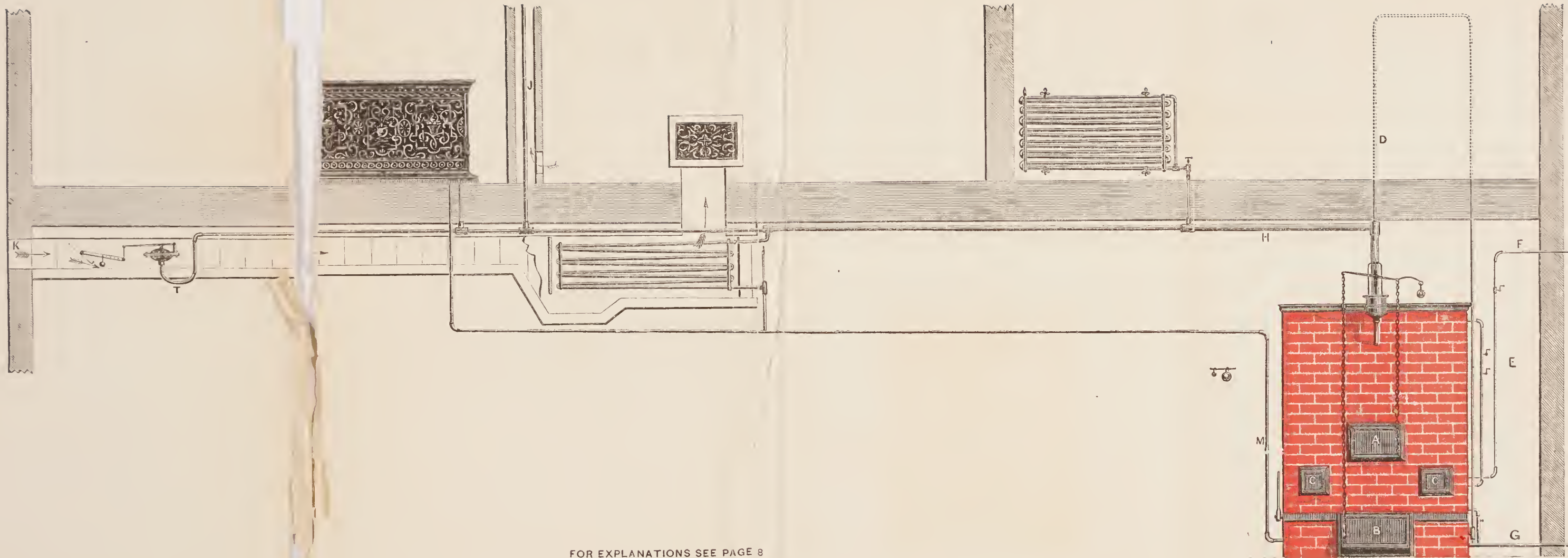
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FOR EXPLANATIONS SEE PAGE 8

DESCRIPTION
OF
BAKER, SMITH & CO.'S
PATENT LOW-PRESSURE, SELF-REGULATING
Steam Warming and Ventilating Apparatus,
FOR
PRIVATE DWELLINGS AND OTHER BUILDINGS.

No. 37 Mercer Street, New York.

IN the cellar, or some other convenient locality, is placed a simply constructed Steam Generator, made of very heavy wrought iron. This, with its necessary appendages, is mounted within a handsome and substantial enclosure of brick and iron, so as to insure the least danger from fire and the greatest economy in fuel. It is usually located at the base of the chimney, thus avoiding the objectionable smoke-pipe. The whole occupies but a small space, (in ordinary dwelling-houses about four feet square by five feet high,) although the size varies according to the amount of space required to be warmed.

The Steam Generator, and all of the pipes connected with it, are tested before use, by a pressure of two hundred pounds to the square inch. This is only to prove their substantiality, as the pressure under which the apparatus operates is limited to five pounds per square inch. At this limit the Generator is at once opened to

the external atmosphere through a large vent, which makes the further accumulation of steam impossible.

From the Steam Generator the hot vapor is conducted through small wrought-iron tubes (no matter how far) to the various points where heat is desired. Our favorite plan is to convey the *air* warmed by steam, (having warmed it in chambers separately provided therefor,) instead of the *steam* itself, to the rooms to be warmed. The steam-warmed air is conducted through flues and registers similar in construction and location to those of the common furnaces. These registers occupy no available room, being placed either in the walls or floors, and allow the admission of heat to be very nicely adjusted simply by moving them by the hand. By this method every opening for the admission of warm air into the living apartments has its corresponding chamber, or reservoir of heat, directly beneath it, in some lower room, or in the cellar. Against the steam-heated surfaces placed within each of these chambers, fresh external air is warmed and conducted upward to the apartments.

By the arrangement of separate and distinct chambers of heat at the base of each vertical warm-air duct, the unequal flow of heated air, as through the usual long and irregular horizontal lengths of hot-air ducts, is avoided.

Where the heating surfaces cannot conveniently be placed below, or where ventilation can be dispensed with, radiators, finished with ornamental designs, or heating stacks covered with handsome screens in the form of pieces of furniture, &c., can be tastefully arranged directly within the rooms to be warmed, and in various other ways adapted to the circumstances of the case.

THE FIRE REGULATES ITS OWN DRAFT. When steam accumulates to any required pressure, (say one-half

pound for moderate weather,) a sufficient mechanical force is obtained, when applied to our sensitive Draft-Regulator, to check the draft of the fire, and consequently any further increase of steam. Or, if an additional room is to be warmed and more steam is used, so that the steam force falls below the one-half pound, the draft door again opens, and the fire and steam increase to the point at which the closing of the draft and the pressure of the steam is fixed.

By simply changing the weights marked, "For Moderate Weather," "For Cold Weather," "For Very Cold Weather," a scale of pressure from 0 to 5 pounds, and a range of temperature from 212° to 228° (sixteen degrees) is obtained, which is a sufficient variety for the ordinary changes of weather.

OUR SELF-OPERATING AIR-VALVE is attached to each radiator, coil, or stack of heating surfaces, which allows the air within their interiors to escape. This must be accomplished before steam can enter, and its heat become available, as air and steam cannot occupy the same space at the same time. This air-valve is also a safeguard against the accumulation of steam beyond a very limited amount, as its operation insures the *using up* of the steam by condensation in all of the heating surfaces. The air could be let out through a vent, operated by hand, and closed by the same means when the steam begins to escape; but this would involve a great deal of time, uncertainty and trouble.

OUR AUTOMATIC COLD-AIR DAMPER is attached to each trunk or duct used for the admission of out-door air. Without this, no heating surfaces can be employed in a direct current of exterior air, without the probability of their freezing up and being destroyed. By

means of it, the in-flow of out-door air to the warm air-chambers is regulated. It allows only such an amount of air to enter as the heating surfaces have capacity to warm properly, and closes tightly when the fire goes out, thus preventing cold or imperfectly warmed air from passing through the registers.

OUR WATER SAFETY-VENT and LOW-WATER ALARM, consisting of a large open tube extending to such a height that the hydrostatic weight of a column of water within it will counterbalance the required limited pressure of steam, is a most important attachment. One end of this tube is attached to the inside of the Steam Generator, and is open at the lowest point to which it is prudent to allow the water to fall; the other end is also open, and terminates over the fire. If the pressure of steam overcomes the column of water in this tube, the water is forced out till the end is no longer submerged, and the steam, unrestrained, blows upon the fire, and, excluding the air, extinguishes it, and otherwise gives notice that the draft door has been carelessly left open. Should the water, through any cause, get too low, the fire is put out by the steam in the same manner as when the pressure is too great. By the use of this safety-vent, the objections to the friction and adhesion of metallic safety-valves, levers, weights, &c., are entirely obviated; this being simply a water seal between the steam in the generator and the external atmosphere.

OUR WATER REGULATOR, through which the water is automatically supplied to the Steam Generator, can be attached. We have a very simple and accurate one, but do not advise its general adoption, as the most perfect of these fixtures *may* fail to operate. The insignificant quantity of water wasted after the proper amount is once

supplied, (the same being used over and over again,) and the trifling attention required to replace it, do not, in our opinion, warrant the risk.

VENTILATION in private dwellings is usually sufficiently secured, in our system, by the exit of air through fire-place openings, &c., which must of necessity make room for the inflowing warm air currents through the registers. But in School Buildings, Hospitals, and places where more thorough and positive ventilation is required, our plan is to place one or more steam pipes directly within the ventilating flues, running through and warming their entire lengths. This we have found, by several practical tests, to be a very efficient as well as simple plan. It must be obvious to all that a constantly heated flue insures a vigorous and reliable draft.

THE ENGRAVING shows the position and relation of the different parts of our apparatus. The whole is simple, substantial, compact, readily understood, and easily managed.

We earnestly ask an investigation of the principles relating to our system of warming and ventilation, as more fully treated in another part of this book. We also urgently invite a most critical and detailed examination of the apparatus itself as erected by us for our customers, and in course of construction at our establishment, where also a complete apparatus may be seen in operation.

Particular attention will be given to the warming and ventilating of Private Dwellings. Our apparatus can be put into houses already built, with but little inconvenience to the occupants, and with very little alteration. In most instances where hot-air flues are in, the same can be used for this mode.

While every part of the apparatus shall be of the *best*, both as regards *durability* and *finish*, the *price shall be as low as is consistent with good work*.

We wish it to be distinctly borne in mind, THAT EVERY ESSENTIAL FEATURE OF THIS APPARATUS IS DIRECTLY OPPOSITE TO THE OLD-FASHIONED HIGH-PRESSURE FORM OF STEAM-HEATING, as explained in another part of this book. Nothing can be more apparent than this upon an examination of our system.

With regard to its features of *safety*, we will here remark, that—independent of the perfect control of the fire, which we accomplish—independent of the large and reliable escape for all accumulation of steam above a very slight pressure—independent of the enormous pressure which every part of our apparatus is *capable* of sustaining—each of which is a reliable safeguard—we *attach to every boiler, without any opportunity of being shut off, a sufficient quantity of steam condensing surface to dispose of all the steam the boiler is capable of making*. This, in point of safety, is equivalent to having the steam carried off into the open air as fast as generated.

SAVING OF FUEL. In this respect we are confident our apparatus possesses superior advantages. By testing the temperature of smoke as it escapes up chimney, it will be seen that all the available caloric of the fuel is consumed in passing over the generator in making steam and heating the returned water.

The draft is so perfectly under automatic control that the fire burns exactly according to the varying condition of the weather, and the requirements of the occupants of the house.

These are the principal reasons why our apparatus is more economical in the consumption of fuel in proportion to the amount of heat produced than any other.

NOTICE.

IN consequence of attempts made by certain parties to imitate our apparatus by appropriating various portions of it and dishonorably copying our patterns, we think proper to state that we have secured *the exclusive patent right* to every important part of our arrangement. We therefore give notice that we *shall prosecute to the extent of the law*, every person infringing upon our rights.

BAKER, SMITH & CO.,

37 Mercer Street,

New York.

EXPLANATION OF ENGRAVING.

THE engraving represents a section of a dwelling house with one of our Steam Generators set in the cellar, showing three modes of applying the heat. The centre room is being warmed in our usual and most preferred manner, viz.: through a register placed in the wall, with the heating surfaces beneath in the cellar. This room is also ventilated by a corresponding outflow of air through the ventilating flue J, as indicated by the arrow. In the centre of this flue is run a steam pipe which rarefies the air and causes a strong upward flow at all times.

The right-hand room is warmed by one of our tubular radiators, (which may be made quite ornamental,) placed directly within it. One pipe supplies the steam, and the same also takes back the water of condensation. The valve at the lower right-hand corner is to let on or shut off the steam. This mode of warming apartments does not insure ventilation, as the same air is heated over and over again.

The room represented on the left is also supplied with direct heat by a stack of heating surfaces, covered with an ornamental fret-work having a top in the shape of a table or some other piece of furniture. The ventilation here, as well as in the one warmed by a radiator, is merely incidental.

The regulator for the draft to the fire is represented with the two chains, one attached to the upper, the other to the lower draft door. Balls of different weight, to determine the pressure at which the draft shall begin to close, are provided, one of which is suspended on the end of the lever of the regulator. Other spare ones are shown hanging against the wall at the left of the generator. These balls are marked to indicate the one required to produce the requisite temperature of steam for any change of weather.

If closing the lower draft does not sufficiently check the fire, the upper one opens, thus reversing the draft, and most effectually stopping further increase of heat. (We have latterly adopted opening a door in the chimney back of the generator instead of opening the fire door, as a preferable plan to accomplish this object.)

A. Feed door for coal, (also used in controlling the draft to the fire.)

B. Ash-pit door, (also used in controlling the draft to the fire.)

C. Small doors to open for cleaning out smoke flues of the generator.

D. Water safety-vent.

E. Water-gauge.

F. Water supply pipe.

G. Pipe for drawing water from the generator, when it becomes foul.

H. Steam pipe for supplying the heating surfaces.

M. Pipe for conducting the water of condensation back to the generator.

K. Duct for supplying out-door air to the heating surfaces of the register.

T. Automatic damper for regulating or shutting off the out-door air.

BAKER, SMITH & CO.

respectfully refer, by permission, to the following parties who have their apparatus.

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- HON. ASA PACKER, house Mauch Chunk, Pa.
- A. E. W. PAINTER, Esq., Pittsburgh, Pa., house Alleghany City, Pa.
- JOHN BACHELDER, Esq., house Norwich, Conn.
- HENRY HOWARD, Esq., Phenix, R. I., house River Point, R. I. (*See letter, page 53.*)
- REV. C. NEWELL, U. S. N., house Worcester, Mass. (*See letter, page 26.*)
- WILLIAM STANLEY, Esq., 16 Wall Street, New York, house Great Barrington, Mass.

JAS. D. ADAMS, Esq., 30 Wall Street, New York, house Pittsfield, Mass. (*See letter, page 37.*)

JAS. D. COLT, Esq., house Pittsfield, Mass. (*See letter, page 41.*)

EDWARD LEARNED, Esq., 48 Pine Street, New York, house Pittsfield, Mass. (*See letter, page 21.*)

WILLIAM POLLOCK, Esq., house Pittsfield, Mass.

M. L. DRESSER, Esq., house Pittsfield, Mass.

PITTSFIELD BANK, Pittsfield, Mass. (*See letter of J. D. Adams, page 37.*)

E. B. BIGELOW, Esq., house Commonwealth Avenue, Boston, Mass.

THOS. G. APPLETON, Esq., house Commonwealth Avenue, Boston, Mass.

R. E. ROBBINS, Esq., house Commonwealth Avenue, Boston, Mass.

WILLIAM H. GLENNY, Esq., house Buffalo, N. Y.

GEORGE B. HICKS, Esq., house Cleveland, Ohio.

Hot-Air Furnaces removed from 85 buildings.

Stoves or Grates, " " 33 "

Steam-Apparatus, " " 15 "

Hot-water Apparatus, " " 7 "



RECOMMENDATIONS.

NEW YORK, March 21st, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: You ask my opinion of your system of Warming and Ventilating, as compared with others. I most cheerfully comply, and if anything I can say will induce a single family to avail themselves of it, or any school committee to adopt its use, I shall feel that I have been of service to such.

I have given the subject of warming and ventilating much attention, and from experience I unhesitatingly say that *steam, as applied by your plan*, is at once the most safe, convenient, effectual, and healthful of any or all modes of producing artificial heat that I have examined.

The health of my family has for a number of years been such as to induce me to spare no pains or expense to secure the most healthful and effectual system of heating my dwelling, and I have used various kinds of hot-air furnaces, and discarded them all in turn, on account of their pernicious influence upon health, to say nothing of the wasteful and extravagant use of fuel. I believe it is impossible to construct a hot-air furnace so that it will be free from dust, gas and smoke, or to manage one so that it will not destroy the vitality of the air by passing over an over-heated surface.

Since I have adopted the use of your plan, all these objections are obviated. The heating surfaces are so far removed from the heating source, that it is impossible to contaminate the air with these deadly influences, and as the heating surface is never greater than about 212° , the air must remain pure.

Another and very important feature in your apparatus is its perfect self-regulation, giving out heat in just the quantity desired and at the time it is needed, without depending upon the servants or others, and thus economizing fuel, and adding to the comfort of the family.

The hot-water apparatus, in its best mode of application is one

step in the right direction. Still it is accompanied with objections which unfit it for domestic use.

It is impossible, in a communication of this sort, to hint at all the points of excellence of the one, or the objections to the other; suffice it to say, that, in my opinion, when the value of pure air is fully appreciated, your "Low-Pressure Steam-Heating Apparatus" will as surely supersede all other methods of warming and ventilating, as gas now does that of other artificial light.

After using your apparatus six years, I can only add that it more than realizes my expectations.

Very respectfully yours, etc.,

A. S. JEWELL,

27 Water Street.

PEEKSKILL, March 1, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: Your improved Low-pressure Steam Warming and Ventilating Apparatus, put up in my dwelling in the fall of 1859, in place of a hot-air furnace, so fully demonstrates all that you promised for it, that it gives me pleasure to volunteer my testimonial of its superior merits.

Durability of material, permanency of construction, agreeableness of appearance, simplicity of mechanism, ease of management, freedom from all danger, economy in fuel, and above all, the purity, healthfulness and even distribution of the air in the apartments warmed and ventilated by it, are, in my experience, qualities of excellence not to be found in any other warming apparatus of the age.

A very noticeable feature of your apparatus or system is its ability to warm rooms at a very remote distance from the furnace, or rather the *boiler*—rooms in the extreme L of my house, some hundred feet horizontally from the boiler, and where my water-pipes have heretofore given trouble by freezing, are now effectually, and in a few seconds, as readily warmed as those within a few feet. We find your steam arrangement in the drying room, also located in the extreme of the L, most efficient, neat and convenient for drying clothes. You locate your warming surface in various stacks, not within the rooms, to disfigure them, but directly beneath each separate register, through which the warm air is supplied. In heating power your arrangement is equivalent to having a hot-air furnace

under each room, while you obviate the gas, smoke, ashes, and other poisonous and disagreeable escapements, so inseparably connected with the use of hot-air furnaces.

No exterior currents of air affect the operation of your apparatus in any way. Let the wind blow high or low—east, west, north or south—the same equable, efficient, balmy atmosphere pervades my entire house, although built of wood, and fully exposed on all sides. One room in particular we could not warm at all with the hot-air furnace, when the wind was in a certain direction.

The principles which you adhere to, of locating your heating surface remote from the fire and its attendant gas, ashes, dust, &c.; of having those surfaces at points where the warmth is actually wanted, and of limiting them to a low but effective temperature; of admitting, by a self-regulating process, that amount of air only that is required for the combustion of the fuel, and of supplying to the various warm-air chambers only that amount of external air which the heating surfaces are capable of warming to a proper degree—not admitting cold or partially warmed air through the registers—are, in my opinion, *invaluable*.

The best evidence of my satisfaction with the apparatus furnished me six years since, is that I have had one put in the house I have just built.

I deem it a duty, as well as great pleasure, to recommend you and your system of artificial warming and ventilating to my friends and the public.

Very truly yours, etc.,

GEO. DAYTON.

OFFICE OF THE SINGER MANUFACTURING Co., }
 CORNER BROADWAY AND GRAND ST., }
 New York, March 22, 1865. }

Messrs. BAKER, SMITH & Co.:

GENTLEMEN: As I. M. Singer & Co. entrusted me to procure a suitable apparatus for warming their show-room and offices, I spent considerable time in ascertaining the best contrivance for this purpose. The low-pressure steam apparatus which you have constructed for them has been in the most successful operation since the fall of 1859, and has given complete satisfaction in every particular.

The apparatus is very simple, requires but little care in its man-

agement, is perfectly noiseless, and readily adjusted to any required temperature. The heating surfaces occupy no available room either in the store or basement. This is deemed an important consideration where space is so valuable.

The store of Messrs. Singer & Co. is an unusually cold one, being situated on the north-east corner of the street, with two frontages, nearly all of which are glass. It has two large single doors, which are constantly being opened and shut. Still your apparatus has supplied an abundance of heat in the coldest weather, with a consumption of only 12 tons of coal.

The size of the store is 90 by 26 feet and 14 feet high.

I am fully authorized by Messrs. Singer & Co. to say that they are greatly pleased with the heating apparatus with which you have furnished them.

GEO. ROSS MCKENZIE.

METROPOLITAN BANK, New York, March 24, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: The Steam Warming and Ventilating Apparatus erected by you in my house at Mamaroneck has been used and thoroughly tested during the past six winters.

It is all you represented it to be. We have had an abundance of pure warm air in the coldest weather, and my family are delighted with the comfort produced by it. I think it a decided success, especially as my house is one of the most exposed in Westchester County. I consider it perfectly safe in every respect, durable in construction, economical in fuel, and the best warming arrangement with which I am acquainted.

Yours, etc.,

GEO. I. SENEY, 110 Broadway.

New York, March 21, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: In reply to your note, asking my opinion of the merits of your Steam Heating Apparatus, I have to say that, after five years' use, I am fully satisfied with its operation, and consider it eminently well adapted to the warming of private buildings, from its safety, economy, cleanliness, ventilation, and its unobtrusiveness to the sight. Yours truly,

EDW. LEARNED, 200 Madison Avenue.

NEW YORK, March 27, 1865.

MESSRS. BAKER, SMITH & CO.

GENTLEMEN: I dislike to recommend any one invention over another, as the ingenuity of the country is so constantly producing improvements, but I can hardly refuse to comply with your request to state my experience in the use of your Low-pressure Steam Warming Apparatus, as I have used it now five years, and found it entirely satisfactory.

I have delayed answering your note because I presumed that persons who intended to heat their houses would examine all the various methods before deciding upon any. If you can induce people to examine your mode of heating, you will have no trouble in procuring its adoption by all those who consult their health, convenience, economy and safety. It strikes me that your plan is particularly adapted to school-houses and all buildings in which people assemble in large numbers, as the introduction of fresh air into the rooms not only heats, but ventilates, which certainly is a desirable improvement to all the court-houses and school-rooms of our city.

There is no question but your plan of heating can be applied successfully to the largest building in the country. The damper for the admission of air to be warmed, and the automatic air-valve, I consider indispensable. I need not add I wish you every success.

Very truly yours, &c.,

OLIVER CHARLICK,
254 West Thirty-fourth St.

NEW YORK, March 18, 1865.

MESSRS. BAKER, SMITH & CO.

GENTLEMEN: Your Low-pressure Steam Apparatus has been the sole reliance for heat in our church since its erection, six years ago, and we take great pleasure in stating that it has given entire satisfaction to all concerned, and is all you represented it to be.

The atmosphere of our church is so much more agreeable than that of those heated by the common modes, that it is a subject of remark to strangers. Although the first cost was greater than common heating arrangements, yet considering the very small available space it occupies, the small quantity of fuel it consumes, its great durability, and above all, conducting (as we sincerely think

it does) to the spiritual advancement of our congregation by giving them a pure atmosphere to worship God in, we consider it a cheap and most essential fixture of our house of worship.

Yours very truly,

W. T. MILLER,
Secretary of Board of Trustees of the Third
Ref. Pres. Church, 23d St., New York.

NEW YORK, June 22, 1860.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: You request my views on the merits and demerits of the Steam Heating Apparatus you put up in my house, which I cheerfully give, since it meets with my entire approval. Demerits (if put up as *you* have put up mine) it has none, so far as I can discover with very close attention during the period it has been in operation in my house, both in very cold and mild weather.

The substantial character of the whole work, its easy regulation at the boiler, freedom from all danger in its use, good ventilation, and pure air, make it, in my opinion, the best heater for private dwellings now in use.

I have used the most prominent hot-air and hot-water furnaces, have discarded both, and now feel satisfied.

Respectfully yours, etc ,

A. A. ALVORD,
10 West Thirty-first Street.

NEW YORK, June 9, 1862.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: I have used your Steam Apparatus for heating my house two winters, and find it far superior to a hot-air furnace. It gives me great pleasure to recommend it to the public.

Yours,

GEORGE W. HENNINGS,
76 Beaver Street.

NEW YORK, March 21, 1865.

This will certify that I employed for heating my house a Steam Apparatus, constructed on the ordinary high-pressure plan, and on one occasion, at least, narrowly escaped a serious accident, owing to a great accumulation of pressure on the boiler.

Feeling insecure with it, I had alterations made by Messrs. Baker & Smith, so as to make it operate on their Low-pressure plan. The danger and annoyance is entirely obviated, and I now comprehend the great advantage of their Low-pressure, Self-regulating plan over the old-fashioned High-pressure system. I consider their Automatic Cold-air Damper and Expansion Air-tube indispensable. I cheerfully commend them and their Apparatus to the public.

PETER COOPER,
9 Lexington Ave.

IRVINGTON, March 17, 1865.

MESSRS. BAKER, SMITH & Co.

GENTLEMEN: In examining the different apparatuses for warming and ventilating buildings, for the purpose of selecting one to put into a large house I was building in a very exposed situation on the Hudson River, I was well satisfied with the general principle and arrangement of the one put in by you, but I could hardly convince myself that there was heating power enough to answer for a building so large and so exposed as mine; but having received so favorable a report from all who had tried it, I was finally induced to put one of yours into my building, and after four years' trial I must candidly say that it has far exceeded my expectations, both as to quantity and quality of heat, being entirely free from gas, perfectly safe, and, if properly tended, not a large consumer of coal. The longer I use it, the better I am satisfied with it. I can confidently recommend it as the best heater and ventilator I have thus far met with.

Yours respectfully,

A. G. TRASK,
42 Warren Street.

SOUTH ORANGE, N. J., March 18, 1865.

MESSRS. BAKER, SMITH & Co.

DEAR SIR: It is with pleasure that I bear additional testimony to the superiority of your Steam Heating Apparatus put up in my house, which I cheerfully give; it meets all my expectations, and gives me great satisfaction.

It will afford me great pleasure to show at any time the perfect working of your Steam Heating Apparatus to any gentleman who

may wish, in my estimation, the best heater for private dwellings now in use.

Yours respectfully,

THOMAS FENNER,
40 Vesey Street, New York.

New York, March 22, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: In answer to your inquiry, I would state, that after five winters' experience with the Steam Apparatus put into my house, I find it quite satisfactory, amply sufficient to warm the house, and very controllable. As to the principle of your method of warming and ventilation, I entirely approve of it, and find your apparatus to work in entire accordance therewith.

Your obedient servant,

J. COUPER LORD,
139 Greenwich Street.

New York, March 23, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: I have had in use in my house your Steam Heating Apparatus the past four years. I am perfectly satisfied with it, and I have no hesitation in saying, (in my opinion,) it is the most healthy, safe, and economical mode of heating now in use.

Respectfully yours,

WILLIAM G. READ,
30 West Seventeenth Street.

New York, March 17, 1865.

Messrs. BAKER, SMITH & Co.

DEAR SIR: The Steam Heating Apparatus you put into my house, after a trial of five winters, has met my utmost expectations.

The only question I ever had in regard to it, was capacity to warm thoroughly the whole house, but I am now satisfied that it would warm thoroughly a house of twice its size.

Yours respectfully,

ESLEY MELIUS,
42 Warren Street.

NEWBURGH, March 23, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: After five winters' experience with the Steam Warming Apparatus erected by you in my house, I take pleasure in stating that it has given me very great satisfaction.

Of the superior quality of the air warmed by steam or hot water, I presume there can now be no doubt, and I still think your method of radiation by pipes the best; certainly no plan that I am acquainted with for warming a house could be of less trouble, or better answer the purpose in all weather.

Fire was kindled in grate 26th October, since which it has never been out, except when dumped, and I do not think it has been dumped oftener than once a month.

In moderate weather like this, when in a country house some fire seems necessary, while much heat would be unendurable, it works to a charm, with very little fuel, and all the drafts and damper in chimney closed; there may be no steam generated, still the hot vapor circulates moderately through the pipes.

I cheerfully recommend your Steam Warming Apparatus in all cases where health and comfort are of more value than the extra first cost of erection.

Yours truly,

GEORGE A. ELLIOT.

HUDSON IRON WORKS, June 4, 1862.-

Messrs. BAKER, SMITH & Co.

GENTLEMEN: The Steam Heating Apparatuses you put up in my houses at Newburgh and Hudson have given entire satisfaction for the past two winters. I consider the principle and general combinations the most perfect of any plans I have seen.

Yours truly,

CHAS. C. ALGER.

WORCESTER, Mass., March, 1862.

Messrs. BAKER, SMITH & Co.

After a winter's trial of your Steam Warming and Ventilating Apparatus, I think I can truly say of it that it is all you promised and all I expected of it. And for the following reasons I may think myself fortunate to have contracted with you for such apparatus—because your price for the work and material seems to have been

very reasonable ; because the work was well and obligingly done, and without extra charge or other unexpected annoyances ; and because of your patient and generous willingness, from first to last, to afford all desired information in respect to the right management of the apparatus.

Yours very truly and respectfully,

C. NEWELL.

NEW YORK, March 17, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: I have had your Steam Warming and Ventilating Apparatus in use five winters. No repairs have been necessary. It has given all the heat I have required, and I never for once have had to resort to any other fire for warming purposes. The heat is delightful, and my family have been entirely free from headaches, so prevalent with them while living in a house warmed with a hot-air furnace. I have found it, too, far more economical, having consumed but six tons of coal during each winter. My house is four stories, 21 feet 6 inches by 55 feet. Yours truly,

R. B. CURRIER,
42 Warren Street.

OFFICE HOPE EXPRESS Co.,
NEW YORK, March 21, 1865.

BAKER, SMITH & Co.

You desire my opinion and experience as to your system of heating. I had one of your Steam Heating Apparatus placed in my house in Somerville, N. J., and have tested it five winters ; and I take great pleasure in bearing testimony to its great value and efficiency, giving us all the heat we need in the coldest weather, a warmth and heat far surpassing any hot-air furnace, with a perfect system of ventilation, and any servant of common capacity can manage it. I consider the whole apparatus perfect, and therefore cordially commend it to the favorable consideration of the public.

A. D. HOPE,
162 Broadway.

JERSEY CITY, N. J., March 20, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: In reply to your favor, I can say I have thoroughly tested your Steam Heating Apparatus the past five winters, and, in

my judgment, it is the most efficient, healthful, and desirable method of warming; far preferable to any hot-air furnace, on the score of health, economy, and freedom from liability to fire.

Should my testimony be of any benefit to you, you are at liberty to use this letter, or, if you prefer, refer to me personally.

Respectfully yours,

T. S. DOREMUS,
7 Erie Place, New York.

NEW YORK, March 17, 1865.

This may inform that for five winters past I have had in operation the Steam Furnace of Baker, Smith & Co.

The heat from it is soft and balmy, and entirely free from the dry and parching warmth of ordinary furnaces. It appears to me that it must be more conducive to health. I am in every respect satisfied with it.

VALENTINE MOTT,
1 Gramercy Park, East Twenty-first Street.

BROOKLYN, March 22, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: After five years' trial of your Steam Heating Apparatus, I am happy to say it fully meets my expectations, giving us at all times an abundance of heat and a pleasant summer atmosphere. It is easily managed and is entirely safe.

I regard it as the best heating apparatus in use, and cheerfully recommend it to any person desiring the best and most simple apparatus.

Respectfully yours,

WM. H. MELLEN,
102 Columbia Street, Brooklyn.

NEW YORK, March 17, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: After long consideration of the subject and a close examination of the various modes of heating houses, I finally adopted your Low-pressure Steam Heating Apparatus.

As to its practical working during the four winters of its use in my house, I have to say that I am more and more convinced of its thorough efficiency in doing the work for which it was erected;

viz., the complete warming of the house and more especially the large room used as a picture gallery and music hall, which in the coldest weather has always been most temperately and agreeably heated.

Respectfully yours,

THOS. WARD,

No. 1 West Forty-seventh Street.

NEW YORK, May 27, 1862.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: It affords me sincere pleasure to state that your Low-pressure Steam Warming and Ventilating Apparatus has, to the very fullest extent, carried out all your assertions in regard to its power, economy, and easy controlment. Having used it for two trying winters, I deem it an act of justice so to advise you; and the more especially as I was prepared to be disappointed. In fact, I had purchased Cannel coal to assist, by having fires in the grates. That necessity has never once arisen—your apparatus needed no help. Thanking you for your personal attention, I remain,

Yours respectfully,

WM. BARCLAY PARSONS,

5 Hanover Street.

505 FIFTH AVENUE, March 21, 1865.

GENTLEMEN: Three winters have passed since I reported to you my entire satisfaction with the operation of your Steam Heating Apparatus. In that time it has never once failed to do its work. It appears to improve by age and acquaintance.

It is now somewhat old-fashioned, and your recent improvements had no doubt rendered its adoption still more necessary for health and comfort.

Yours respectfully,

WM. BARCLAY PARSONS.

11 DUTCH STREET, NEW YORK, March 21, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: After resorting to a great many modes to make my house comfortable, by the purchase of stoves, grates, portable and fire-place heaters of various descriptions, without success, I was finally induced, four years ago, to place in my house one of your

Self-regulating Steam Apparatuses, and I must say that I am entirely satisfied. Consequently, I recommend them to all that wish pure and generous heat, with economy of labor and fuel. You can, with pleasure, refer any to me.

Yours respectfully,

JOSEPH WILDE,
Ross Street, near Lee Avenue, Brooklyn.

BROOKLYN, March 18, 1865.

Messrs. BAKER, SMITH & Co.

It gives me great pleasure to add my testimonial in favor of your Steam Heating Apparatus.

It has given entire satisfaction—it warms the house thoroughly in the coldest weather, and can be easily regulated to the most moderate temperature.

The longer I use it, the better I like it. It has been used four whole winters and a good part of the winter when the house was finishing. It is now apparently as good as the day it was put in. There has been never a dollar expended on it in any way excepting to clean the flues.

In all the time we have never had occasion to build a fire in a grate; the house being thoroughly heated by your Apparatus, and with a consumption of fuel not more than one half used for the same quality of heat from a Culver's furnace.

It cost me on an average about \$10 a year at old prices, to keep the hot-air furnace in order, for pipe, cleaning out furnace, and putting up to keep the gas from coming out.

The heat produced by your Apparatus is most agreeable, and its superiority in point of healthfulness cannot be doubted.

JOHN A. CONE,
90 Remsen Street.

NEW YORK, March 20, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: In reply to yours of the 10th inst., requesting in fuller terms than those already expressed my opinion of your Steam Warming Apparatus, I take pleasure in stating that after a test of four winters' use, I consider it the most economical, healthful, and complete method of heating houses in my experience.

The Apparatus is easily controlled, giving no trouble, and dis-

pensing an atmosphere unlike that of the hot-air furnace, which is dry and oppressive; but furnishing a temperature more like the natural heat of summer.

How strange that sensible men, for the sake of saving a few dollars in the first outlay, continue to make use of the common Hot-air Furnace, and live in an atmosphere that is certain death to plants, and no less detrimental to themselves; while these same persons will spend thousands upon a showy but useless piece of furniture!

In point of economy, judging from my own observation, I will in a few years have saved, in the consumption of coal, sufficient to pay the difference of expense between your apparatus and the common hot-air furnace.

Another recommendation is its exemption from liability to accident by fire, which will render it an important consideration in cases of insurance, &c. Very respectfully yours,

MONTAGNIE WARD,
130 William Street.

NEW YORK, March 15, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: The Low-Pressure Steam Apparatus erected by you in my new house, has since its completion given entire satisfaction. I can recommend your Apparatus as being *the best* with which I am acquainted. Yours truly,

J. L. BROWN,
Cor. Lexington Av. and 62d Street.

BERGEN POINT, N. J., March 22, 1865.

I have one of Baker, Smith & Co.'s Heating Apparatus in my house; have used it five seasons, and find it perfectly satisfactory in every particular.

My house is large, 62 by 46 feet, and two and a half stories, and it is heated throughout without difficulty. Steam can be got up in twenty minutes; the heat is very pleasant. I think it also perfectly safe, and do not think it extravagant in the consumption of fuel.

I do not hesitate to say, that I believe it to be the best heating apparatus yet invented.

Yours,

N. B. LANE,
90 Broad Street, N. Y. City.

NEW BRUNSWICK, N. J., March 17, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: I have used your method of heating by steam for five winters, both in city and country, and consider it as very far superior to the old method of hot-air furnaces.

My prejudice was against the use of steam for private dwellings; but I find your system so easily controlled as to give no trouble, while it furnishes humidity enough to the atmosphere to render it both agreeable and healthful.

Yours respectfully,

JAMES BISHOP,

3 Beaver Street, New York.

NEW YORK, March 18, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: In answer to your inquiries, I cannot do better than give the following extract from a letter sent by me to a friend, in reply to a similar communication:

"I have had an experience of five winters' use of the one which they put up in my house, near Manhattanville, in a situation very much exposed to the severe north-western winds which are so prevalent here in winter, and I can say as the result of this experience, that I am quite satisfied with the working of it. I had tried for four years an approved hot-air furnace; sometimes being obliged to use my grates in connection with it—always during the high winds, of which I have spoken above; and the furnace and grates together did not give the same amount of heat which I now get from the Steam Apparatus alone; the consumption of coal being from 25 to 30 per cent. less with the steam than formerly.

"As to the quality of heat, I can hardly say too much in favor of its superiority over the hot air in the ordinary furnace, which is very apt to leak and infect your rooms with noisome gas and a variety of other unpleasant smells: with the steam there is none of this, nor can any burning out or wearing away of the boiler cause the escape of gases which can find their way through the registers; the dry and parched feeling which the air has, after passing through a furnace, is not felt in the air fed over the steam-coils; my furniture does not crack, nor does the woodwork of the house shrink, as it did with the hot-air furnace; and though this is owing in part to their previous exposure to its drying effects, yet I notice the same

results in reference to such parts as, being newer, never were so exposed.

"As to the management of the apparatus, it is extremely simple, and really consists of only two points, viz: keep water enough in the boiler, and coal enough under it. The attention requisite in keeping the ash-pit clear of ashes, and the fire-place clear of *clinkers*, is the same as for a furnace or even for a common coal-stove.

"In conclusion, I think it fair to say, that, with less trouble and less fuel, you can get as much heat by this plan as by any other, and that the *quality*, so to speak, is more agreeable than that of any other mode of warming, excepting perhaps, hot water."

Yours very truly,

ROBERT O. GLOVER,
158 Broadway.

NEW YORK, March 23, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: The Steam Heating Apparatus which you put in my store about six years ago, works to my entire satisfaction.

Yours,

JOHN C. JOHNSON,
36 Howard Street.

NEW YORK, March 17, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: Your Patent Domesticated Steam Apparatus has been the sole reliance for heat in my dwelling for the past five winters. It has every qualification that you claim for it, yielding the most agreeable warmth to every part of the house, being in great contrast in this latter particular with the hot-air furnace which I previously used. It is very easily managed, is economical of fuel, safe, simple and durable; and I would not now change it for any of the numerous and varied heating apparatuses now known, although supplied to me free of charge. You are at liberty to refer any inquirer to me, at my house, 39 West 19th Street, or at my store, 27 Water Street.

Yours truly,

C. D. VAN WAGENEN.
27 Water Street.

NEW YORK, 26 West 20th Street,
March 22, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: The delicate health of a member of my family has, for many years past, induced me to give special attention to the improvements made for heating dwelling-houses.

After discarding several hot-air furnaces, I decided to try your *Low-pressure steam apparatus*. I did this mainly from the *strong* recommendation of an old friend, who had been a confirmed invalid for many years. He pronounced it, what I have found it, "the perfection of heat." To an invalid it is invaluable. With good ventilation of pure air, it furnishes a delightful and uniform heat, entirely free from smoke or coal-gas, and is regulated with the least possible trouble. It affords me great pleasure to give you this testimonial in its favor. Nothing but absolute necessity would induce me to be without it.

Very respectfully yours, etc.,

JOHN H. SWIFT,
Canal Street.

NEW YORK, March 23, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: I have had one of the Steam Heating arrangements of your invention in use throughout the past four winters in my dwelling, East 39th Street, between Madison and Fourth Avenues, this city, and like it very much.

Your decided success in reducing to practical effect, in this apparatus, the principles justly assumed in your pamphlet as essential to health, should commend it to public favor.

Yours, respectfully,

A. W. WINANS.

MAMARONECK, March 15, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: Having used your steam warming apparatus in my house for the five past winters, it affords me great pleasure in testifying to its efficiency in giving all the heat I wish, and that of the most pleasant kind. The working of the dampers, with the regulating of the steam, far exceeds my expectation. In fact, I find the whole apparatus so perfectly simple and safe, that it may be intrusted to any person of ordinary intellect with perfect safety.

I therefore, without hesitation, recommend it as the best system I have ever known for warming buildings of every class.

Yours, respectfully,

SCHUREMAN HALSTED,

52 Murray, New York.

MAMARONECK, N. Y., March 15, 1865.

MESSRS. BAKER, SMITH & CO.

GENTLEMEN: When we built our new church, we decided to have the best warming arrangement that could be procured, as we considered the quality of the atmosphere which our congregation was to breathe of the first importance. After making a careful examination of the various modes of warming and ventilating, we adopted your system; and have found that it is practically all we anticipated and all you promised—which was a great deal.

We had it in operation through the coldest weather of the past six winters. It is efficient, simple, safe, substantial, economical, and, above all, yields an abundance of evenly-distributed and summer-like warmth in the church.

We cheerfully recommend it to our brethren as the best mode of warming all places of public worship.

SCHUREMAN HALSTED,

JOSIAH P. KNAPP,

Building Committee of M. E. Church
at Mamaroneck, N. Y.

OFFICE OF THE CONTINENTAL INSURANCE CO.,
No. 102 Broadway, New York, June 16, 1862.

MESSRS. BAKER, SMITH & CO.

GENTLEMEN: After careful investigation of the merits of the various modes of heating by steam, and after obtaining the testimony of many intelligent gentlemen, we decided to introduce your apparatus, and accordingly made a contract with you, on terms sufficiently guarded to insure the right of an unbiassed judgment upon it.

Our new building, Nos. 102 Broadway and 1 Pine Street, 120 feet deep by 22 feet wide, divided into 25 different offices, has been completely warmed during the past winter solely by your apparatus. We have used it continuously, and take great pleasure in stating that it fully equals our expectations. The heat furnished

has been ample, and of the most pleasant character. The arrangement adopted in the basement and principal story, of bringing in copious volumes of moderately warmed air from heating surfaces located in the cellar, and drawing it off rapidly through rarefied ventilating shafts, thus giving us constantly all the freshness of the external atmosphere, combined with the most genial warmth, is, we believe, the great ultimatum in the science of ventilation. We much prefer this method of warming to that effected by direct steam radiation without any special provision for ventilation. So long as pure air is the prime necessity of life, too much importance cannot be attached to this subject, and to its bearing on the atmosphere of banking rooms, offices, &c., as well as private dwellings. The duty intrusted to you of giving us the *best warmth* and *the most efficient ventilation* has been fully performed. The apparatus is in other respects as represented—safe, simple, durable, and very economical of fuel.

Having had so satisfactory an experience with it, we think you fully entitled to this public acknowledgment of the fact.

Very respectfully,

H. H. LAMPORT, Sec'y.

NEW YORK, March 20, 1865.

MESSRS. BAKER, SMITH & CO.

GENTLEMEN: I have used your steam apparatus for warming my house during the past two winters, and it has given me every satisfaction.

The heat is soft, pleasant and agreeable, and not extravagant in the amount of fuel consumed.

It is superior to any other warming apparatus of which I have any knowledge. Respectfully,

JAMES M. CONSTABLE,

33 West 23d Street.

NEW YORK, March 18, 1865.

MESSRS. BAKER, SMITH & CO.

GENTLEMEN: Your note requesting my opinion of your heating apparatus was read by my wife, who asked me if I had answered it, and upon my replying "not yet," she exclaimed with earnestness:

"Let me reply to it."

"Why, what would *you* say?" I asked.

"Say!" she responded with vehemence, "say *everything* that can

be said in its favor. Say that I have a chronic throat complaint, and that for the ten years I have lived North I never breathed any heated air without difficulty until last winter. Say that you can have a balmy June atmosphere in December. Say that neither myself nor any one of my five children have had a cold, or a sore throat, or a doctor's bill to pay since that heater has been in the house. Say that I would not be without it for any money, and that a person who has any difficulty about breathing and don't have that heater if he can get it, is a confounded ——"

How much higher her climax would have reached in her great appreciation of your apparatus, I do not know, but as I considered that she had "covered the case," I stopped her and said that I would answer the note myself.

I can only add to her testimony, that I have had an experience with various kinds of heaters and furnaces for more than a quarter of a century, and that before I decided that your heater was the best in the market, I had made a thoroughly practical and scientific investigation of the subject. I felt the necessity of some kind of heating apparatus that would enable my wife to endure our winter climate. I selected your heater, and have every reason to be satisfied with my choice.

For its simplicity of arrangement, its facility of attention (owing to the automatic fire-damper and self-adjusting cold draft), its total freedom from danger, from fire or explosion, or any other cause, the perfection of its ventilation, its economy of fuel, and the softness and purity of its atmosphere, I have no hesitation in saying that it will give entire satisfaction to every one, and that it is, in all respects, far superior to any other heating and ventilating apparatus.

Yours, etc.,

W. J. A. FULLER,

51 Liberty Street.

NEW YORK, March 20, 1865.

MESSRS. BAKER, SMITH & Co.

GENTLEMEN: I take pleasure in stating that I have used your Steam Apparatus in my late residence in Pittsfield, Mass., for the past four years to my entire satisfaction, having substituted it for a Chilson's furnace.

The apparatus you placed in the *Pittsfield Bank* was equally satisfactory.

Your obt. servt.,

J. D. ADAMS, 30 Wall Street.

CLINTON AVENUE, BROOKLYN, March 18, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: You ask about the consumption of coal by your heater. I had my house, about 40×60 , well heated last winter, with less than twelve tons of coal.

We had no trouble with the apparatus, and on the whole are well pleased with it, particularly the superiority of steam over a dry heater; no consideration would induce me to change.

Yours truly,

CHARLES PRATT,
106 Fulton St., New York.

OFFICE OF THE NEW YORK LIFE INSURANCE CO., }
112 & 114 BROADWAY, }
NEW YORK, March 20, 1865. }

Messrs. BAKER, SMITH & Co.

GENTLEMEN: We have had in successful operation during the past winter and a part of the winter preceeding, in our office, your valuable Steam Warming and Ventilating apparatus, and are entirely satisfied therewith. Previous to its introduction we had experimented upon several others, but they did not come up to the standard of our requirements. We have great confidence in our present establishment. A sufficient time has elapsed to thoroughly test its capacity, and we have no hesitation in saying that it has thus far proved eminently successful.

I remain with great respect,

Your obedient servant,

MORRIS FRANKLIN, President.

LEATHER MANUFACTURERS' BANK, }
29 WALL STREET, NEW YORK, March 18, 1865. }

BAKER, SMITH & Co.

ESTEEMED FRIENDS: During the two past winters we have used your Steam Heating apparatus to heat our Banking Room as well as the entire Building. We have been well pleased with it, and I believe it has proved satisfactory to all of our tenants.

I have also used one of them in my dwelling house, and can say that my family have been well pleased with it.

Respectfully, your friend,

WM. H. MACY,
29 Wall Street.

BROOKLYN, March 18, 1865.

MESSRS. BAKER, SMITH & Co.

DEAR SIRs: After having tried and found wanting the hot-air furnace, and my family having suffered from colds and coughs caused by irregular heating and the gas arising therefrom, I concluded to have you place one of your Steam Heating Apparatus in my dwelling, and I cheerfully bear witness that it is all you represented it to be, heating my house thoroughly at all times, at no greater expense than the heating of one room by the old method.

It is now four years in use, requires no repairs, and is so simple, safe and self-regulating that no one need have any fear of its perfect safety and utility.

Its healthfulness and cleanliness are beyond question, as all who have used it can testify.

The fact that it requires to be supplied with water but once in three or four days, and that the fire need not be renewed oftener than once a month, is sufficient, I think, to recommend it to all who desire real comfort.

Yours truly,

STEPHEN A. DODGE,

Gates, near Franklin Ave.

NEW YORK, March 17, 1865.

MESSRS. BAKER, SMITH & Co.

GENTLEMEN: In reply to your note of enquiry as to the working of the Steam Heating Apparatus which you put in my house in the fall of 1863, I cheerfully give my testimony, and would say that the apparatus has worked to my entire satisfaction, requiring less care and attention than any heater I have ever had, the fire having been rekindled but *twice* from October to April, when it was allowed to die out for the season.

It warmed my house throughout with a pure, healthy atmosphere, easily regulated for moderate, cold or very cold weather. In short, I believe it to be the safest, best and most durable heating apparatus at present in use.

Yours, etc.,

GEORGE J. BYRD,

12 Warren St.

Messieurs BAKER, SMITH & Co.

GENTLEMEN: I have used your Steam Warming Apparatus for three winters. Having made frequent and careful observations respecting the composition, quality and temperature of the air, as heated by your apparatus, I am quite satisfied that it is *the best* contrivance for heating dwellings now in use. Your arrangements are such that the requisite quantity of oxygen is always supplied to all parts of the house, while there is an entire absence of those deleterious agents, like carbonic oxide, sulphuretted hydrogen, and other gases which so often escape from other furnaces.

I regard the introduction of your heater as a sanitary measure of much importance.

Yours truly,

E. E. MARCY, M. D.,
396 Fifth Avenue.

NEW YORK, March 17, 1865.

OFFICE OF THE CITIZENS' GAS COMPANY, }
SAN FRANCISCO, July 13, 1864. }

MESSRS. BAKER, SMITH & Co.

GENTLEMEN: Your favor asking my opinion of your apparatus for heating and ventilating buildings with low pressure steam, has been forwarded to me here.

In reply, I have to state, that during the fall of 1863, I had one of your apparatus put in the office of the Metropolitan Gas Light Company, corner of 42nd Street and Broadway, New York. The rooms are large and much exposed by many windows and doors opening on the street, and while the rooms were kept at a uniform temperature, the consumption of coal was far below that consumed by the ordinary plans of heating, now so extensively in use.

Your method of ventilation and introducing pure air in just sufficient quantity, I consider superior to any other method I have yet seen, and whilst the first cost of your apparatus is necessarily greater than that of many others, yet I do not hesitate to say, that the economy and saving of coal more than compensates for that, whilst the comfortable and healthy atmosphere produced by it, is beyond all consideration of cost. I cheerfully and with confidence recommend its use to all my friends.

Respectfully yours,

JOHN P. KENNEDY.

PITTSFIELD, MASS., March 15, 1865.

Messrs. BAKER, SMITH & Co.

After three winters' experience, I cheerfully state that your steam apparatus gives entire satisfaction. Though our climate is very cold in winter, and my house is, like most country houses, quite isolated, I have had no difficulty in keeping it thoroughly warmed.

I have, as you know, by a little contrivance of my own so arranged that I can assist the regulator when the house is too warm, by means of a chain which comes up in the hall, and by which I easily open the door of the furnace.

The most unskilful domestic manages it without trouble.

Respectfully yours,

JAMES D. COLT.

NEW YORK, March 20, 1865.

Messrs. BAKER, SMITH & Co.

DEAR SIRs: Having substituted your steam heating apparatus in my house in place of the ordinary hot-air furnace, I can only say, that after testing it for three winters, I am so well pleased with it that I can cheerfully recommend it to any desiring to avail themselves of the best system for warming houses at present known.

Very truly yours,

CYRUS CLARK,

10 East 41st Street.

NEW YORK, March 17, 1865.

Messrs. BAKER, SMITH & Co.

180 & 182 Centre Street, N. Y.

GENTLEMEN: In reply to your note of yesterday in regard to your heating apparatus, we would say that we used the heater during the past two winters and found it satisfactory in every respect, taking up less room, and being managed with less trouble than anything of the kind we have ever seen used.

Yours respectfully,

OGDEN & BLEWETT,

325 Broadway.

NEW YORK, March 17, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: It affords us pleasure to say that the steam heating apparatus which you put into our stores in 1863, has

proved perfectly satisfactory. The *quality* of the heat produced by fresh air passing over coils of pipe heated by steam, is superior to any we ever experienced.

Respectfully yours,

J. C. HOWE & CO.,

57 & 59 Worth Street.

NEW YORK, March 21, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN : I have used your steam apparatus two seasons, and am much pleased with it. I take pleasure in recommending it to all.

Respectfully yours,

HORACE SMITH,

27 West 38th Street.

NEW YORK, March 17, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN : It affords me great pleasure to say that the steam heating apparatus you put in my dwelling in 1862 gives entire satisfaction. During the last three winters it has kept my house comfortably warm in the coldest weather without any aid from fire in the grates ; affording an ample supply of warm air, pure and healthful, free from all smell of coal-gas or other impurities. I have also found it very easily managed, as well as economical in its consumption of coal ; and have no hesitation in recommending it as the best apparatus for heating dwelling-houses I have ever met with.

Very respectfully yours,

WM. HENRY SMITH,

10 West 38th Street.

121 Chambers Street,
NEW YORK, March 17, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN : In reply to yours asking my opinion of your "Steam Heating Apparatus," I would say, having used it the past three winters in my dwelling-house, I am well pleased with it in every particular. It more than answered my expectations. I give it as my opinion that for health, convenience, comfort, safety from fire, freedom from dust, for the ease and simplicity in tending it, and for economy in heating an entire house, there is no other method as good.

I have no hesitation in recommending it very highly, and feel confident that every intelligent person who will investigate the subject will come to the same conclusions.

Yours truly,

CHAS. STORRS.

Before using your Heating Apparatus, I was rather slow in the faith, but after using it three years with great comfort and satisfaction, I cheerfully and fully endorse all my brother has stated above.

Truly yours,

AUGUSTUS STORRS.

THE PARK BANK, }
New York, March 18, 1865. }

Messrs. BAKER, SMITH & Co.

GENTLEMEN: We are well pleased with the Low-Pressure Steam Warming Apparatus put up by you in this Bank, and consider it a very great improvement on our former method of warming by hot air.

The heat is more uniform, more easily regulated, and far more agreeable, and in our opinion more healthy.

Very respectfully,

JAS. L. WORTH,

Cashier.

NEWTON, N. J., March 17, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: In reply to your inquiries as to the operation of the "Steam Heating Apparatus" put by you in my house, I am happy to state that it fully meets my expectations, and I am quite sure it far surpasses every other method of house warming and ventilation yet discovered, and of which I have seen any account.

Before adopting this plan of yours, I endeavored to inform myself of all other methods in use, and after the fullest investigation I could give the subject, I selected yours only on account of what I conceived to be its very superior merits. And I now speak with the most confident assurance when I say that it fully performs all that my investigation led me to expect it would do, and all that you claim for it in your circular explaining the principles of its operation.

Its most striking merits in my judgment are its great economy in the consumption of fuel, its power of *warming* your whole house with a summer atmosphere without *heating* any part of it, and the *perfect ventilation* which it furnishes to every apartment which it warms.

Respectfully,

Your obed't serv't,

JOHN LINN.

NEW YORK, March 18, 1865.

Messrs. BAKER, SMITH & Co.

I would say in reply to your note of the 10th inst., that I most cheerfully bear testimony to the complete success of the heating apparatus put up by you in my dwelling, No. 18 East 29th Street, about two years since. I know of no better evidence to offer of my entire satisfaction with your heater, than the fact that after the most rigid examination and careful watching, I am unable at this time to point out a single fault or suggest an additional improvement. The experience of two years satisfies me that the apparatus answers all that a most requiring public could expect of it. As compared with other heaters, most of which I have tried with more or less satisfaction, it stands vastly superior, as well for the simplicity of its construction, the safety, convenience and elegance of its arrangements, as for the happy effects of its soft, even, and life-invigorating current of warm air. I therefore look upon it as a great desideratum in every dwelling, and particularly in a climate so changeable in its temperature as that of our city, and I heartily wish you the success your exertions and the invaluable patents you possess entitle you to.

I am, very faithfully,

Yours, &c.,

BAYARD CLARKE,

51 Liberty Street.

OFFICE OF THE NORTH AMERICAN FIRE INSURANCE Co., }
 No. 114 Broadway, New York, March 18, 1865. }

Messrs. BAKER, SMITH & Co.

GENTLEMEN: In replying to your favor asking an opinion as to the practical working of your steam heating and ventilating apparatus, I can state its results better by comparing it with the one formerly in use in this office. The apparatus you removed

was as complete a failure as could be conceived. It was high-pressured—limit 75 lbs. The pipes were in iron cases in the rooms, and fed with cold air from the outside, conveyed through the cellar by means of tin pipes. With this apparatus the former occupants of the premises were quite unable to be comfortably warm in extreme cold weather, say from 15° to 20° above zero. Beside which the noise arising from it was so loud and constant as to greatly annoy the occupants of the office, and seriously interfere with the operations of officers and clerks. Offensive odors arose from it, and at times the water overflowed and soiled the carpet and floor; in summer it was of no value whatever.

The apparatus attached by you to the same boiler and pipes, has had the test of two winters' use, and in summer, and its results have been most satisfactory. With 20 lbs. of steam—thermometer at 10° above zero outside and nine-tenths of the pipe attached, the thermometer rose to 90° —while we were perfectly free from noise and effluvia. By means of the steam air-washer, we have been supplied in all weathers with an abundance of pure fresh air—without a particle of dust—making the office thoroughly warm in winter, and in summer pleasantly cool.

In relation to danger from fire, we know that the high-pressure apparatus as often set up is decidedly unsafe. But as far as our examination has enabled us to discover, your apparatus in that respect is perfectly free from danger. In short, everything desired has been fully and completely accomplished, and we have no hesitation in recommending your apparatus for heating and ventilating as perfectly safe from fire and explosion, and as desirable in every respect.

Very respectfully,

Yours, &c.,

R. MASON, Supt.

In the autumn of 1863, Baker & Smith put into my house their apparatus for heating it by steam in coils of iron pipe.

I have now had the experience of two winters, the last being a severe one; and have found the temperature throughout the house warm, and the air, which is constantly changed, both agreeable and healthful.

JOSEPH WALKER,

31 East Thirty-sixth Street, N. Y.

3d Mo. (March,) 1865.

NEW YORK, March 20, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: It gives me pleasure to have this opportunity to testify to the entire satisfaction of the working of your Steam Heating Apparatus which you put into my house nearly two years since, and for durability, comfort, safety and every other quality recommended by you, I know of no heating apparatus equal, and think it cannot fail to please any one who gives it a fair trial.

Respectfully yours,

J. M. BENHAM,
75 Remsen Street, Brooklyn.

NEW YORK, March 20, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: Your Steam Heating Apparatus has proved in every way perfectly satisfactory. I can confidently recommend it as the nearest perfection of anything I have met with in that line. You are at liberty to refer to me. Yours truly,

JOHN F. COOK,
389 Washington Avenue, Brooklyn.

NEW YORK, March 17, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: The Steam Apparatus you placed in my house in the fall of 1862, has given entire satisfaction. You are at liberty to refer any parties to me. Yours truly,

SAMUEL B. CALDWELL,
20 Old Slip.

NEW YORK, March 17, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: During the past winter I have had your apparatus in my house, in Oxford St., Brooklyn, furnishing at a moderate cost pure air properly heated; the economy in fuel, safety against fire, ease of control, and freedom from disarrangement, are qualities, in my judgment, not to be found in so great perfection in any other arrangement or system of heating and ventilating that has yet been presented to the public.

R. F. MASON,
114 Broadway.

ELIZABETH, N. J., March 17, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: It gives me pleasure to add my testimony in favor of your system of affording pure artificially warmed air to private dwellings.

One of your apparatuses has been the sole reliance for heat in my house for the past four years. My house is a large wooden one, and exposed on all sides. I can say no more than that I am perfectly satisfied with it.

Yours truly,

J. B. BURNET.

ELIZABETH, N. J., March 17, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: With pleasure I respond to your inquiry as to the working and also as to the heating of your Steam Apparatus, erected for me two years since; it gives me perfect satisfaction, and particularly so through the extreme cold weather of the past winter, and I unhesitatingly recommend it to all who desire a good heater combined with economy and safety.

Respectfully,

C. H. GENUNG.

TROY, N. Y., March 20, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: I have used your steam warming apparatus in my dwelling during three seasons.

I have taken great pains to acquaint myself with the merits of every description of warming apparatus for dwellings, and prefer yours to any other.

Yours truly,

P. THALIMER.

Troy, March 20, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: I have used your Low-Pressure Steam Apparatus during the past winter, which has been very severe, and take great pleasure in saying that it has given perfect satisfaction. It has thoroughly heated and ventilated my house in the coldest weather, and is at all times entirely under the control of the most ordinary intelligence.

I most cheerfully recommend it as altogether the best and most economical system of house warming with which I am acquainted.

Truly yours,

S. M. VAIL.

TROY, March 18, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: I have used your Steam Heating and Ventilating Apparatus during the past winter. We have had severe weather with little interruption, which has required a fire kept up during the whole period. The fire has not been out since the 25th of October, and yet the consumption of coal to this date has been only about thirteen tons of 2,000 lbs. We have made comfortable during the entire winter a space of 35,000 cubic feet, keeping the temperature from 70° to 76°, besides using the heat temporarily in other parts of the house; this temperature being kept up night and day. This space in a corner building, as mine is, would have required two large furnaces, and consequently more fuel. The ventilation I regard as the best feature of your apparatus; the purity of the air discharged through the coils adds immeasurably to the comfort of all in the house; this appliance alone renders your apparatus valuable to those who value fresh air and plenty of it.

Yours truly,

JOHN B. PIERSON.

RIVER VIEW, TROY, March 18, 1865.

Messrs. BAKER, SMITH & Co.

MY DEAR SIR: I should do myself injustice, after a winter's experience of the comfort my family has enjoyed from the operation of your Low-Pressure Steam Warming Apparatus, did I not express to you my acknowledgments for the same.

My house, which you know is situated on Mt. Ida, exposed to the full force of the wind, and in which two of Fox's hot-air furnaces for the previous five years have at times been unable to keep the atmosphere at a temperature to prevent my water pipes from freezing, has during the past winter been at all times at a delightful temperature, seldom below 65 degrees Fahrenheit, even with the mercury at 20 degrees below zero in the open air.

I do not know that I can say more in its favor than that it has more than equalled my expectations, and that I unhesitatingly

recommend it to my friends as the best method of heating a dwelling-house of which I have any knowledge.

Truly yours,

D. THOS. VAIL.

OFFICE OF THE TROY IRON AND NAIL FACTORY,
TROY, N. Y., March 20, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: In answer to yours of 10th inst., I have to say that your steam heating apparatus has been in operation in my house for the past three years, and given entire satisfaction. You are at liberty to refer to me at any time.

Yours truly,

WM. F. BURDEN.

ALBANY, March 23, 1865.

Messrs. BAKER, SMITH & Co.

180 & 182 Centre Street, New York.

Three years ago you put one of your Steam Heating and Ventilating Apparatuses in my dwelling-house, No. 195 State Street, Albany, and thus far it has done all you promised it should.

The arrangements are quite simple and not likely to get out of order or repair. Any person who can make a good fire and keep it going can take care of the whole thing without interference with other duties about the house. I consider the apparatus superior to any other mode I have yet seen for warming and ventilating. All who study their health and comfort will not fail to appreciate its great advantages.

You are at liberty to refer to me on this subject.

Yours very truly,

GEO. E. GRAY.

NEW YORK, March 18, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: The heating and ventilating apparatus put up in my house gives good satisfaction, and I take pleasure in saying that I believe it to be the best in use for heating private houses.

Yours respectfully,

GEO. M. WOODWARD,

77 Beekman Street.

NEW YORK, March 23, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: We have been using one of your Low-Pressure, Self-Regulating Steam Warming Apparatus for over two years in our stores corner of Greenwich, Jay and Washington Streets in this city. The basement covering a space of $218 \times 39 \times 11$ feet, and first floor and offices a space of $112 \times 23 \times 14$, we believed you would be unsuccessful in producing a temperature of 65° in the former and 70° in the latter in the winter season, and had the apparatus put in with the expectation of proving a failure. In justice to yourselves, we beg leave to testify our satisfaction in a contrary result—and recommend your apparatus to those wishing economy of fuel over hot air of at least 75 per cent.

Yours respectfully,

JOHN TAYLOR'S SONS,

334 Greenwich Street.

PEEKSKILL, March 20, 1865.

GENTLEMEN: In reply to your inquiry as to the operation of the Steam Warming and Ventilating Apparatus, I am glad to be able to say that we are much pleased with the mild summer-like atmosphere produced by it, and believe it superior to other arrangements in use, both on account of safety and healthfulness.

Having been in use six years, it still gives entire satisfaction, and I would not willingly return to any other mode of warming my house. I think it peculiarly adapted to invalids suffering from pulmonary affections, as my husband, though a confirmed invalid, frequently remarked that he breathed more comfortably than he had done in previous years, and believed that he had transferred to his own house the genial air of a more southern clime.

Very respectfully yours,

Mrs. GEORGE F. HUSSEY.

KINGSBRIDGE, N. Y., March 17, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: You ask my opinion of the relative merits of heating buildings by hot-air furnaces or steam apparatus.

I will detail my experience of both, and give the facts, as far as they have come under my observation, respecting each; you and your friends can then draw what conclusions you like, and place

what confidence you think proper, in my opinions deduced therefrom.

In the fall of 1856 I had a hot-air furnace put in the dwelling, then being erected. This was selected after careful examination of the various patterns in the market, and supposed to be the best contrivance of the kind then in use. I would here remark that the house is larger than ordinary dwellings, is situated on a high knoll, completely isolated, and exposed to winds from every quarter—in short, the situation is bleak, exposed, and in winter very cold. Consequently a furnace of the largest size was procured, an extra-sized “fire-pot” was purposely cast, the whole was erected in the best manner, flues having been left through the walls to conduct the heat to the different apartments. The furnace was found on trial not to generate sufficient heat to render the building comfortable; an additional furnace was therefore procured and placed in a different part of the building; the two, however, were insufficient, so finally it was necessary, in addition, to have a fire in the grate of the sitting room. I would not be understood as inferring that hot-air furnaces cannot be made sufficiently large to heat any building, but as simply stating that these two furnaces were inadequate to heat sufficiently the building above described.

We however got along as well as we could, by keeping fires in them night and day, and, with the addition of the grate, kept tolerably comfortable.

At the expiration of three winters, (two of which, however, we spent in town, the furnaces not then being in use,) there was perceived an unpleasant, sulphurous odor throughout the house, which was at first attributed to carelessness in the man who had charge of the fires, in leaving the furnace door open; then to the winds blowing down chimney, &c. Finally, it could not be accounted for; at times it was so unpleasant as to require all the windows and outside doors to be opened, to change the air. This continued more or less until January, 1861, when it became unendurable. On a Sunday morning of that month, *all* the inmates of the house were affected with violent pains in the head, languor and general debility. The fires were immediately extinguished, doors and windows thrown open, the domestics sent off to breathe pure air, which fortunately recovered them.

The following day, Monday, the furnace was taken down, and it was found that the alternate action of heat and cold had expanded

and contracted the iron so that the joinings of the various parts had become opened, through which the noxious gases of combustion had entered the hot-air chamber, and, combining with the heated air, circulated throughout the building. As it was now deemed utterly impossible to exist for any length of time with comfort in such an atmosphere, it was decided to dispense with hot-air furnaces. I think it impossible to construct one that will not, *in time*, be subject to this objection, viz., opening the joints by expansion and contraction of the iron consequent on the change of temperature to which it is exposed—the effect of this necessarily being to loosen the joints connecting the various parts; hence the escape of the noxious gases of combustion into the building.

I would further remark, that the heated air (previous to the leakage of joints) was unpleasant, being too dry, arising doubtless from its passage over red-hot iron, which depriving it at least of a large portion of its oxygen, renders it not only unpleasant, but in my opinion unfit for respiration.

Having from the above causes entirely abandoned the idea of ever again erecting or using a hot-air furnace, or living in a building heated by one, and yet, it being necessary to have heat in some way, the question arose, whether it were better to return to grate fires (which were troublesome,) or devise a safe and pleasant way of warming a building without their difficulties.

In investigating this question, I met with your pamphlet, after a careful perusal of which, I concluded that if about half it stated was true, your Apparatus would answer the purpose. At any rate I decided to try it; had one put in the house, and have now used it for the last five winters with entire satisfaction. It completely warms the house throughout, including a conservatory twenty-three feet in length, attached thereto. The heat in the different apartments is nearly equally diffused throughout the building; the attic being as warm as the principal floor, or, if any difference, a trifle warmer. There has been no fire in the grates since your contrivance was put up, nor any required, the single fire in the boiler being all-sufficient to keep an adequate and even temperature throughout. There is but little trouble in attendance, one of the laborers replenishing it but three times a day, (the fire continuing through the night,) and occasionally letting on a *small quantity* of water to supply the waste of the boiler. I deem it perfectly safe from any danger of explosion—at least I fear none; nor can I conceive of a

boiler, capable of sustaining a pressure of two hundred pounds, exploding under a pressure of five pounds, which is all that has been necessary to use in this case.

Finally, I would say that I have had no trouble with your apparatus for the five years it has been in use, nor has it been of any further expense, and that I am fully satisfied with it, and acknowledge that it has much more than answered my expectations, being naturally incredulous, and believing about one fourth I hear.

I think this plan of heating should become more general, and presume it would, (being safer, more healthy, more agreeable, and less troublesome than any other,) were it not for the extravagant prices you charge for them; about three times the price of hot-air Furnaces. Yet I hope you may be more reasonable in future, and trust when you shall have made what money you wish, you will reduce the price.

Respectfully yours, etc.,

JOHN F. SEAMON.

RIVER POINT, R. I., March 10, 1865.

Messrs. BAKER, SMITH & Co., New York.

GENTLEMEN: It affords me pleasure to inform you that notwithstanding the severity of the winter, your Steam Heating Apparatus has operated to my entire satisfaction.

Although the furnace which we removed when we adopted your apparatus was of modern and approved construction, the air from it was not deemed agreeable or healthy for sitting rooms, and we therefore maintained five other fires in the main part of the house, relying upon the furnace for the purpose only of warming the halls. The quantity of coal consumed in the furnace during a winter was estimated to be from twelve to fifteen tons. The steam apparatus has required, I should say, something less than eleven tons up to this time. We have therefore warmed the entire house except the kitchen apartments with about the same quantity of fuel as was formerly used for warming the halls alone, thus saving the expense and trouble of five fires. For the first time, the house has been perfectly comfortable during the entire season; the interior doors standing open as in the summer. Although we have never used any but the smallest weight on the draft regulator, we have had an excess of heat most of the time. Notwithstanding this exhibit, however, I do not consider economy the primary excellence of the in-

vention. Its chief value in my opinion is its capacity to produce a perfectly pure, healthy and agreeable atmosphere. I have also observed another peculiarity in the heat which I have never seen alluded to, and which I cannot explain, viz., its diffusive nature. There seems to be so little difference in the temperature of different parts of the room, that the members of the family sit scattered about as regardless of the register as if there was no heat transmitted through it. Its safety is probably its next recommendation. This fact seems to be known to the insurance companies, as the company where I insure expressed their gratification at the substitution of steam for hot air, when I gave them notice of the change. As next in order I should commend the apparatus for its cleanliness. Since its introduction we have never had a particle of coal dust or any manifestation of coal gas in the house, although we encountered both far too frequently before. It is evident, of course, that we cannot have anything of the kind under our present arrangement. I anticipated considerable trouble in taking care of the apparatus; but having taken some pains to learn the philosophy of it and its mechanical construction and operation, and having given it some personal attention when we commenced making fires, I have found no difficulty in its subsequent action or management. Our guests have often expressed their amazement at the genial character of the heat; and the absence of the parched and dry sensation in the mouth so common where furnaces are used, has been frequently commented upon. Contrary to our intention, but as your Mr. Baker prognosticated, we have abandoned the wood fire in the library, and do not intend to resume it while your apparatus works as efficiently and satisfactorily as it does now. I think that you stated last summer when the job was completed, that you had lost money by the contract. Such being the case you, are at liberty to draw on me for the amount of the deficiency.

Very truly yours,

HENRY HOWARD.

BERGEN POINT, N. J., March 22, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: I received your note asking me to give my opinion of the merits of your Steam Heating and Ventilating Apparatus. In reply, I have to say, that after three winters' use, I am fully satisfied with its operation, and consider it eminently well adapted

to the warming of dwellings from its safety, economy, cleanliness, ventilation, and its soft balmy heat, and can cheerfully recommend it to public favor.

Yours with regard,

ELISHA L. WALTON.

NEW YORK, March 23, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: In answer to your enquiry, we are happy to state that we have had your Steam Warming and Ventilating Apparatus in use in our store during the past winter, and can bear most conclusive evidence as to its superior merits. We have had some very unsatisfactory experience with *other* steam warming arrangements, but yours renders perfect satisfaction so far as tested, and we take pleasure in recommending it.

SCOTT & BALDWIN,

505 Broadway.

NEW YORK, March 16, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: The Steam Heating Apparatus which you put in my dwelling, gives entire satisfaction, and I regard it as a luxury, the heat being so pleasant, and as I believe very healthy.

Yours respectfully,

JOHN McGEE,

135 Broadway.

HOME INSURANCE COMPANY, OFFICE, No. 135 Broadway,

NEW YORK, March 16, 1865.

Messrs. BAKER, SMITH & Co.

GENTLEMEN: The Steam Heating Apparatus which you put in this building, furnishes a very pleasant heat, and is satisfactory in all respects.

Respectfully yours, &c.,

A. B. WILLMARTH.

A LITTLE FAMILIAR TALK

WITH OUR CUSTOMERS.

IN appearing before you in a new edition of our descriptive pamphlet, we take the opportunity to tender our thanks for the words of commendation and encouragement lavished upon us in time past. Our business has so increased that we are obliged for want of room to change our place of business, as will be seen by our new address.

We now occupy a large and commodious building, easy of access from the great thoroughfare, Broadway, and have very greatly increased facilities for building our apparatus and exhibiting our work. Our opportunities, we believe, are not equaled by any similar establishment in the world.

We have recently made several important improvements, which, with many particulars not referred to in this book, will be cheerfully explained to those who may visit our establishment.

In the construction of our apparatus we adhere strictly to the rule to allow nothing but of the most substantial kind. In the formation of the necessary joints, we admit nothing more perishable than the iron itself. Rubber, cloth, yarn, cement, paint, putty, &c., &c., which enter into the construction of apparatuses with which we have sometimes to compete, can have no place in ours; and although we may occasionally lose a

job for want of discrimination on the part of the purchaser between a well made and a poorly constructed apparatus, we believe our interest lies in rejecting all work that cannot be done in such a manner as will ensure satisfaction to our customers and credit to ourselves.

The employment of *steam* for domestic warming is comparatively new. The public are as yet uneducated in the details of the business. We therefore feel justified in venturing a few words of advice to those in search of the best apparatus for warming and ventilating. Examine for yourself the quality and quantity of the material used, and the liability of the apparatus to get out of repair. See exactly how the joints of the several parts are constructed. Investigate carefully the mode proposed for ventilation in connection with heating, and finally, use your own *good common sense* in preference to the assertions of *any* interested parties.

Our aim is to construct an apparatus that will prove permanent, safe, simple and effective, and ensure PURE ARTIFICIALLY WARMED AIR IN LIVING APARTMENTS.

From a Report of the Special Committee of the Board of Education of Jersey City.

It is proper to state that these heating arrangements your Committee examined, and report upon as above, are the only ones yet introduced which claim to be superior to the ordinary hot-air furnaces, and, as we have been informed, are the best specimens of the kind ever erected.

After investigating this subject thus thoroughly, and giving it a very careful consideration, your Committee are convinced that the Baker & Smith "Low-Pressure Steam Heating Apparatus" has the decided preference

over any other that they have examined—for the following reasons, which they think will be fully established upon any trial of investigation:—the advantages are found in economy, *durability of material and construction*, in entire safety from explosion, self-regulating, ease of management, freedom from dust, gas, and smoke, *even and quick* in operation, sending the heat to all the rooms at once, efficient in ventilation, and nicety of adjustment to any required temperature. It occupies but small space, and is economical in the consumption of fuel.

The heat from this apparatus, being perfectly free from all impurities, is peculiarly adapted to delicate lungs and sickly children.

Another important feature in this apparatus is its entire safety from fire. The boilers are set in such manner that it is quite impossible to set the building on fire by the most careless management. The heating surface is so far removed from the power to produce the heat, that it is not possible to produce any of the unpleasant effects that are caused by the other modes of heating.

Much more might be said in behalf of this system of warming and ventilating, but your Committee deem this sufficient; but would refer to the subjoined extract from a lecture by Professor E. Y. Robbins, delivered at the Cooper Institute, on the subject of ventilation as influencing health and longevity.

From all the foregoing facts, which your Committee are confident can be established to the satisfaction of every member of this Board, they recommend that measures be taken to introduce a *Messrs. Baker & Smith's "Low Pressure Steam-Heating Apparatus"* into School No. 2 at as early a day as shall be deemed expedient.

Ventilation as Influencing Health and Longevity.—

Professor E. Y. Robbins delivered the second of his course of lectures on "Sanitary Science," at Cooper Institute: his subject was, "Ventilation as Influencing Health and Longevity." He commenced by saying, that air was the prime necessity of life—that we could live more days without food than we could minutes without air. The purpose of our breathing was, first, to supply the blood with oxygen, which is the life-sustaining principle of the air; and, second, to free the blood from carbonic acid and other impurities. The air which we breathe is found on expiration to have lost a large part of its oxygen, and to be impregnated with carbonic acid gas—the substance which often proves fatal to persons who descend into wells, and which is the active agent of death in cases of suicide by burning charcoal. It produces death whether retained in the blood, or inhaled into the lungs—the poisoning process in both cases being precisely the same. To produce death by that agent, it was by no means necessary that it should be breathed in its pure state. Dr. Carpenter had ascertained that air containing five or six per cent. of carbonic acid gas would produce immediate death, and less than one-half that quantity would soon prove fatal; and Dr. T. Herbert Barker had ascertained by experiments with this substance, that an animal in an atmosphere containing only two per cent. of carbonic acid, would die in about two hours. Now, the air which we exhale from the lungs contains, according to standard authorities, about five per cent. of carbonic acid; and hence, if exactly the same air were reinhaled, it would quickly prove fatal. It is a substance that is constantly accumulating in the blood, and, if it is not as constantly removed, will speedily produce death. The process of breathing is but the instinctive effort of nature to free

herself from this poison. But air which has once been in the lungs will no longer perform this office, being already saturated with carbonic acid. Hence the necessity of inhaling fresh air at every breath. The importance of this was illustrated by Dr. Southwood Smith, who said : " Stop the respiration of an animal, or confine it to air which has already been respired, and carbon accumulates in the venous blood, and mixes with the arterial blood. In half a minute the blood flowing in the arteries is evidently darker ; in three-quarters of a minute it is of a dusky hue, and in a minute and a half it is quite black. Every particle of arterial blood now disappears, and the whole mass becomes venous, sensibility is abolished, and the animal falls down, and in three, or at most in four minutes, the heart entirely ceases its action, and can never again be excited."

Now, if effects are proportioned to their causes, and if an atmosphere impregnated with five per cent., or one-twentieth part of this volume, of carbonic acid, will thus produce death in a few minutes, what must be the probable effect of breathing, for twenty or forty years, even the much minuter proportions which must be present in every inhabited room where there is not a constant ingress and egress of air ?

It must lower the standard of health, and shorten the duration of life. But not only is the air in a close room thus constantly being impregnated with carbonic acid gas to the amount of about twenty-eight cubic inches per minute for each adult man occupying such room, but there is also, according to the best authorities, constantly being discharged by the lungs and pores of the skin an equal amount, by weight, (that is, about three or three and a half pounds in twenty-four hours,) of effete, decaying animal substances, in the form of in-

sensible vapor, which we often see condensed in drops upon the windows of crowded rooms and railroad cars. These drops, if collected and evaporated, leave a thick, putrid mass of animal matter. The breathing of these exhalations is believed to be quite as efficient in producing disease as carbonic acid itself. But there is still a third deterioration produced in the air by respiration, and that is the loss of its oxygen. Oxygen is the vital and life-supporting principle of the air; and it is found that when the air enters the lungs, the blood absorbs about forty per cent. of the oxygen which it contains.

It is upon this we live; and the air that is exhaled being deficient, by almost one-half, in this vital element, of course can no longer support life. And as we inhale about five hundred cubic inches of air every minute, we of course deprive that quantity of air of forty per cent. of its oxygen each minute. The Creator has provided for the constant and complete removal of these poisonous exhalations, by causing the expired air to rise, by its increased warmth and consequent levity, quickly above our heads, and beyond the reach of a second inhalation, and by sweeping it away by the winds; but by our impervious ceilings and tight walls, we obstruct the operation of this beneficent law, and prevent those poisonous exhalations from escaping. Hence the air of a close room, though occupied but by a single person, becomes, from the very first moment of occupancy, impregnated with these impurities, which accumulate more and more, the longer it is occupied without ventilation, and the more it is crowded.

It certainly would be difficult to over-estimate the importance to life and health of the purity of the air we breathe, and it would also be difficult to determine to what period of duration human life might be prolonged,

did we, and had our ancestors always breathed a perfectly pure atmosphere. A most remarkable and convincing illustration of the effects of the quality of the air we breathe, upon health, is to be found in the experience of the armies of England and France during the late Russian war. England, out of a total force of 93,959 men engaged in the campaign in the Crimea, lost 33,645, of which number only 2,658 were killed in action, and 1,761 died of wounds, while no less than 16,298 died of disease at the seat of war, and about 13,000 were sent home on account of sickness, many of whom, no doubt, afterwards died. To every *one* taken to the hospitals on account of wounds, *twelve* were taken there on account of disease. The chief destroyer was typhus fever. M. Boudens, surgeon-in-chief of the French army, in a letter written home during the war, says of this disease: "It is engendered by crowding and want, either in hospitals, prisons, or on board vessels. The disease may, indeed, be called forth or removed at will." And he adds, "The first remedy is pure air and powerful ventilation." The greatest mortality in the English army was during the early period of the war; after the sanitary commissioners arrived, and commenced their operations by securing greater ventilation, the sickness was stayed, and finally disappeared. The great panacea was fresh air. In the French army, where no sanitary reforms were introduced, the great mortality continued, and increased, thus showing clearly that the changes made by the sanitary commissioners in the English army were the sole causes of the decrease of mortality where they labored. Recurring again to our buildings here, the lecturer said: In our school-rooms the matter is still worse; while in our railroad cars we have actually less breathing room than the wretched prisoners in the black-hole of Calcutta

—they having had about forty cubic feet per man, while in our ears we have an allowance of only about thirty cubic feet.

In addition to this, the lighting of our rooms in the evening is a source of great contamination to the air—each gas-burner being estimated to generate as much carbonic acid gas as the respiration of four persons, or more than one hundred cubic inches per minute. Every gas-burner should have a ventilating tube to carry off the products of combustion, and convey them entirely out of the room, as is the case in the Houses of Parliament, and many other public and private buildings in England.

In conclusion, he stated his belief that by due attention to sewerage and ventilation, the mortality of this city would be decreased ten thousand every year.

In answer to a call, Dr. Halliday referred to recent visits he had made to the houses in this city in which a number of families lived together. He said that the *Italian* residents here especially were in the habit of living several families together in one comparatively small room. He also mentioned that in a single block he found *forty-five* families—not a single one had a child living; when he asked for their children the answer generally was, “God has taken them away to heaven.” This terrible infant mortality was caused by want of cleanliness and ventilation in their residences.

From the N. Y. Evening Post.

“The usual modes of warming buildings are attended by many evils, which directly affect the health and lives of our families, who are obliged to remain within doors by far the greater part of the time. The entire absence of the means of ventilation in most cases, and the fail-

ures which have followed most attempts in this direction, make the subject one of the most vital importance. Bad air is a *slow* poison; that is the trouble. People go on taking it into their lungs day after day and night after night. They grow pale, their lungs suffer, the circulation is languid, they take colds readily; the chest, the stomach, the skin become disordered, and a host of chronic diseases attack them. A little carbonic acid taken every day does not kill a man. It is almost a pity it don't.

"If a red-hot stove or a furnace destroyed instantly one man in every town daily for a week, there might be some salvation for the nation. If, instead of fainting away in crowded and badly ventilated public assemblies, people occasionally died outright in convulsions, the authorities would take the matter in hand, and make it penal for the owners of such buildings to open them for public use without attending to the proper conditions for the preservation of health. When a thing is only a slow poison, the age is in too much of a hurry to attend to it. Thousands of dollars are lavished on luxuries and superfluities, while the air in our dwellings is poisoned and burnt by heating arrangements whose only recommendation is that they are *cheap*. In other words, our wealthiest men are *too poor to afford* pure air for themselves and families. The vital life-element is supplied in their green-houses and conservatories regardless of expense, while scions of the human stock, buds and blossoms of immortality, are permitted to wither and decay in the sickly atmosphere produced by stoves and hot-air furnaces."

ARTIFICIAL
WARMTH & VENTILATION,

AND THE

Common Modes by which they are Produced.

BY

WM. C. BAKER,

PRACTICAL ENGINEER IN WARMING AND VENTILATING.

REVISED EDITION.



NEW YORK:

PUBLISHED BY J. F. TROW, 50 GREENE ST.

1865.

INTRODUCTORY.

There is no subject of a material nature to which such vital importance can with propriety be attached, as to that of the construction of our dwellings; for in them we are to live and find a home with our families and friends. And nothing connected with that home, its health, comfort, and happiness, can justly command the important considerations that are connected with the quality of the air—the element upon which chiefly depends the existence of those most dear to us, our wives and children, who spend the greater part of their lives within doors. Hence the artificial heat, which may make that air impure, becomes a subject of paramount significance.

In the Sun nature has kindly provided us with a magnificent warming apparatus, which alone, for a great portion of the globe, is all-sufficient. Through the day he diffuses genial and equal warmth, and at evening withdraws to permit the cool repose of the night. He gives a reflective and conductive heat, with the warmest rays nearest our feet, instead of our heads: the quality, too, is at once of the purest, and always below an excessive temperature.

But unfortunately for the inhabitants of that section of the earth in which we reside, the sun yields a sufficient external warmth but a small portion of the year, and we are compelled to resort to some artificial substitute for the remainder. We have that grand luminary

and heater for a model, and the nearer we imitate him the nearer shall we come to perfection in the construction and application of artificial warming apparatus.

In speaking of the most common contrivances for creating artificial warmth, it is admitted that they all possess, to a certain extent, the superficial object to be attained, viz. : heating *power*. But this is in reality but an elementary principle, therefore we shall speak of qualities that are not so apparent, and leave the reader to exercise his own judgment in determining which plan comes nearest to the standard of the great prototype, the Sun, and combines the qualities appertaining to a perfect system for creating and maintaining artificial heat.

OPEN FIRES.

One of the earliest modes for warming, and one which at the present time is more universally adopted than any other, is the burning of wood or coal in an open fire-place at one side of the room. There are various modifications of this arrangement, dating all the way back from the primitive andirons, or fire-dogs, within an uncouth fire-place of clay or stone, to the modern grate with its glittering surroundings of silver and marble ; but they are all subject to the following objections.

1. *Waste of fuel.* It has been found that in a common open English fire, seven-eighths of the heat produced from the fuel ascend the chimney, and are absolutely lost. This lost fuel is thus accounted for. One half of the heat is carried off in the smoke from the burning mass, one quarter is carried off by the current of the warmed air of the room, which is constantly entering the chimney between the fire and the mantel-piece, and mixing with

the smoke lastly, one-eighth part of the combustible matter is supposed to form the black and visible part of smoke, in an unburned state. Some writers have even gone so far as to estimate the loss of heat in an open fire at fourteen-fifteenths of the whole.

2. *Unequal heating at different distances from the fire.*—

This forms a remarkable contrast with the uniform temperature in the air of a summer afternoon. In rooms with a strong fire, in very cold weather, it is not uncommon for persons to complain of being “scorched” on one side, and “pierced with cold” on the other; this is particularly the case in large apartments; for as the intensity of radiating heat (like light) is only one-fourth as great at a double distance, the walls of the room farthest from the fire are but little warmed, and therefore, reflect but little heat to the backs of persons grouped round the fire.

3. *Cold draughts.*—Air being constantly required to feed the fire, and to supply the chimney-draught, the fresh air which enters by the crevices and defects in the doors, windows, floors, &c., is often felt most injuriously as a cold current. “There is nothing more dangerous to health than to sit near such inlets, as is proved by the rheumatism, stiff necks, and catarrhs, not to mention more serious diseases, which so frequently follow the exposure. There is an old Spanish proverb, thus translated :

If cold wind reach you through a hole,
Go make your will, and mind your soul,

which is scarcely an exaggeration.” The current of fresh air which enters to feed the fire becomes very remarkable when doors or windows are opened, for the chimney can take much more than it otherwise receives when the doors and windows are shut; and thus the

room with its chimney becomes like an open funnel, rapidly discharging its warmed air.

4. *Cold to the feet.*—The fresh air which enters in any case to supply the fire, being colder and specifically heavier than the general mass already in the room, lies at the bottom of this as a distinct layer or stratum, demonstrable by a thermometer, and forming a dangerous cold-bath for the feet of the inmates, often compelling delicate persons to keep their feet raised out of it by footstools, or to use unusual covering to protect them.

5. *Bad ventilation.*—Notwithstanding the rapid change of air in the room, perfect ventilation is not effected. The breath of the inmates does not tend towards the chimney, but directly to the ceiling; and as it must therefore again descend to come below the level of the mantel-piece before it can reach the chimney, the same air may be breathed over and over again. In a crowded room, with an open fire, the air is for this reason often highly impure. As another source of impure air in a house, it may be noticed that the demand of the chimneys, if not fully supplied by pure air from about the doors and windows, operates through any other apertures.

6. *Smoke and dust.*—These are often unavoidable from an open chimney, much affecting the comfort and health of the inhabitants of the house, and destroying the furniture. Householders would make great sacrifices in other respects to be free from the annoyance of smoke. In large mansions, with many fires lighted, if the doors and windows fit closely, and sufficiency of air for so many chimneys cannot therefore enter by them, not only do the unused chimneys become entranees for air, but often the longest and most heated of them in use overpower the shorter and less heated, and cause the

shorter chimneys to discharge their smoke into the room.

7. *Loss of time.*—During the time every morning while the fires are being lighted, the rooms cannot be used; and there are, besides, the annoyances of smell, smoke, dust, and noise, all of which are again renewed if the fire is allowed to go out and to be relighted in the course of the day.

8. *Danger to person and to property.*—How numerous are the losses of property by carelessness as to fires is well known to all, while the less frequent but more distressing loss of life too well attests the danger to children, and to females thinly clad, often consequent on an open fire.

Such are the objections enumerated by Dr. Arnott, to which we may add, the annoyance and injury occasioned by the unavoidable ashes and dirt attending this mode of heating. Coal and kindling cannot be habitually brought into a nice room without injury to the carpet, aside from the probability of sparks of fire falling upon it. What careful hand can remove the ashes and cinders, or poke the fire, without setting afloat a storm of ash-flakes, which settle upon books, furniture, &c.?

The danger to human life by exposure to open fires, is too well attested by the fact that nearly every newspaper contains the sad account of death from this cause. We copy from a city paper two melancholy examples:—

“Yesterday noon, Ellen Lynch, a child four years of age, living at No. 7 Clark Street, was left by her parents in a room with her little sister. On the return of her mother, the child was found dead on the floor, with all her clothes burned off, as is supposed in consequence of her dress having come in contact with the grate.”

“A child two and a half years of age, left to itself, attempted to climb up on the fender, for the purpose of taking something off the mantel-piece, and in doing so fell inside, between the fender and the fire, and was thus roasted alive.”

STOVES.

Next in the progress of improvement come the innumerable patterns of stoves. With the exception that they can be cheaply bought, and are somewhat more economical of fuel, their use is attended with all the evils of the open fire-place and grate, with the additional objections of taking up valuable room, being unsightly, and, worst of all, they produce some of the evils of the hot-air furnaces in presenting a heating surface, the temperature of which is sufficiently high to kill the animalculæ of the air, and scorch the myriad particles of dust floating therein, rendering it unfit for respiration, and so dry as to injure wood-work and furniture. The evaporating vessel of water on the stove is but a poor remedy for this evil. Stoves also come in competition with our lungs in the consumption of the oxygen of the air to support combustion, and do not recompense us for the loss, as in the ventilation which we get from an open fire.

Stoves, when the heating surface is so far extended by long lengths of smoke-pipe or otherwise, as to take up and impart directly to the space to be warmed, all of the caloric set free by combustion, are, of all methods, the most economical of fuel.

When stoves and open fires were first brought into use, it was through absolute necessity, instead of any merits which they chanced to possess. The latter came in vogue when wood was most abundant, and the fire-place was built capacious enough to serve the double purpose

of cooking and warming. We date back but a few years to the first use of the grate, and the substitution of coal for wood.

Custom alone has familiarized us to the danger and inconvenience of these two methods of creating artificial heat. Should a stove, for instance, even of the most ornamental pattern, now be erected in our dwellings for the first time, its uncouth, black visage alone would be a matter of unendurable disgust. But when we take into account, above all things else, the thousands of human lives which statistics show are annually destroyed by exposure to open fires and stoves—children playing within reach of these fiery fiends—women drawn within their fatal circle—are we not led to believe that custom can habituate us to the most apparent and appalling of evils?

Here is a specimen of the old familiar story :

Ann Clifton, died at her residence, No. 43 Laurens Street, from the effects of burns received on Sunday evening, when her clothes took fire from a stove. Coroner's verdict, "Accidental death."—*New York Sun*.

HOT-AIR FURNACES.

Of all potent inventions for the destruction of human life which custom has tolerated under the head of "modern improvements," none rank higher than the common hot-air furnaces. The evils *arising* from them are so numerous and so *glaringly* apparent, that we can conceive of no other reason for their general introduction than that they are "*cheap*." There are other arrangements for warming before the public, which are, at least, exempt from the intolerable objections which are inseparably connected with these; yet these Molochs

of iniquity are still welcomed as household companions because their first cost is small. When we take into consideration the great amount of fuel which they consume, the injury to wood-work and furniture, the high rates of insurance charged where they are used, the many valuable buildings they destroy by fire, and, above all, the invaluable human lives which are being daily sacrificed—*burnt-offerings* to this system—who can call them *cheap*, although their market value may be small? Men are wise in not employing them to yield warmth to the flowers and exotics of the green-house and conservatory. But human plants—flowers of immortality—may sicken by inhaling their polluted breath, and wither away under the Sirocco-like blasts of this abominable system of heating.

THEIR INJURY TO HEALTH.

The fundamental evil of hot-air furnaces lies in the very limited amount of heating surface they contain. The air we are to breathe should never come in contact with surfaces sufficiently heated to char the innumerable, minute, dusty particles of decayed animal and vegetable matter always floating therein. 250° is the limit to which any surface should be heated. Or it should be kept at a temperature so low, that, in ordinary cases, with the surface situated below, as hot-air furnaces are, 1 square foot of heating surface would be required (to give a sufficiency of heat in the coldest of weather) to every 100 cubic feet of space to be warmed. Take, for instance, a house containing eight rooms, averaging in size 16 feet square and 12 feet high = 24,576 cubic feet of space to be warmed. This would require of heating surface, at a temperature of the above limit, 245 square feet; but a hot-air furnace of the size usu-

ally put in to heat such a house, would not exceed 75 square feet of heating surface. To make this small amount sufficient in cold weather, it is necessary to heat it to a temperature ranging from 800° to $1,000^{\circ}$. The baking temperature of an oven is 320° ; wood will ignite at 350° ; but what may be said of the healthfulness of air heated against surfaces which exceed the burning point of wood by 650 degrees! By excessive heating, the air itself is decomposed, its animalculæ destroyed, and their innumerable dead carcasses—if we may so speak—are thrown into the apartments being heated. The effluvia of the decomposition of this mass of animal matter constitutes a part of the disagreeable odor which escapes from the registers. Air being almost a perfect non-conductor of heat, one particle does not warm another; therefore the air which actually comes in contact with the over-heated furnace is the air by which we are warmed and which we inhale.

The leakage of gases is a gigantic evil of this mode of heating, and is inseparably connected with it. A furnace cannot be cast whole, and consequently it must have joints, which, by the continual strain of heating and cooling (expanding and contracting), will invariably become broken,—no matter how substantially they may be put together with bolts, screws and cement. These joints come against the fire on the inside, and the air to be heated on the outside: consequently, whenever a joint is broken, the gas from the burning coal is drawn, by the greater current of the air rushing upwards into the rooms that are being warmed.

A furnace may keep “gas-tight” for a few weeks, or it may apportion out its gaseous poison in such perpetual regularity as to inure the occupants of the house to an unconsciousness of its presence; but a compound

of carbonic oxide gas mingled with smoke and ash-dust, can be detected escaping from ninety-nine out of every hundred furnaces that are in operation, even by olfactory organs of ordinary ability. We were present, a few evenings since, at an evening meeting in a fashionable Church (but too poor to permit pure air and health to its members), where two ladies fainted by reason of the above-named evil; and the entire audience, no doubt, were affected to the extent of a headache apiece, from the same cause.

While thousands may be pining away by sure degrees through this domestic iniquity, the public are only startled by an announcement like the following—the death of two highly valued citizens. We copy from the *New York Times*:

“Mr. and Mrs. Sawyer, of Haverhill, Mass., died in their bed, on Saturday, 7th inst., in consequence of breathing coal-gas which escaped from a newly-erected furnace. When Mr. and Mrs. Sawyer were discovered in the morning, artificial respiration was unsuccessfully attempted as a means of restoring life. The air which escaped from their lungs was strongly impregnated with the gas which they had breathed.”

There is also an *arsenical* escape from the highly heated iron, which, too, has its poisonous influence upon the air we are to breathe. And this is what dealers in hot-air furnaces call “*ventilation*”—a trite term emblazoned on their warehouses, as the surest decoy to catch purchasers.

Danger from Fire.—Another evil of the hot-air furnaces is their constant liability to fire the premises to which they are attached. The small quantity of fire-surface and heating-surface which they contain, renders it necessary to drive the fire to the highest point, in cold

weather, and in moderate weather, the lack of any reliable control of the draft of the fire, with most of the heat shut back and concentrated at the furnace, engenders a dangerous heat, besides causing a wasteful consumption of fuel. These conditions, also, produce in the furnace and its surroundings a heat so intense as to open seams in the iron and brick-work, through which escape fire and combustible gases.

Many furnaces are erected without "double tops," or any separation between the furnace and the ceiling directly over it. Such are condemned by all insurance companies, and are pre-eminently dangerous. Nor is the danger confined to the cellar. The hot-air flies from the furnace at a temperature high enough to ignite any combustible thing with which it may come in contact. The tin-conducting pipes serve as protectors so long as they retain their bright reflective surface; but the various gases arising from the furnace, and the friction of the rapid current of air, soon change the bright, non-conducting surface of the pipes to dull conductors of heat, the solder will melt from the joints, crevices will be opened, and the contiguous wood-work set on fire. It has long since been ascertained that the continual action of heat will char tin and even burn it away. The pipes often become broken by the settling of the walls into which they are imbedded. It may with truth be said that it is hardly possible to erect a modern hot-air furnace without the liability of fire. Official investigation proves that two-thirds of the fires are traceable to this system of heating, and the fire insurance companies have been compelled to increase their rates where this kind of heater is used, while they offer a premium for safer modes.

The unequal distribution of heat is an important

sanitary reason against the employment of hot-air furnaces in producing artificial warmth. The unnaturally heated air, rushing into the apartment with the velocity of a tornado, ascends at once to the ceiling, and, rendered specifically lighter than the air already in the room, it descends only as that may be displaced. The thermometer will, in a common room, indicate a difference in temperature of 10° to 15° between the floor and ceiling. Hence the headaches, dizziness, cold feet, and the many indispositions to which the occupants of such rooms are continually subject. There are other causes and conditions which operate to prevent this highly rarified air from being equally apportioned in an apartment; but were the air as pure as the element from which it was perverted, such inequality of distribution would be an unanswerable argument against the system.

The same pieces of iron that form the fire-pot also heat the air from which warmth is derived, and these in the hot-air furnaces can only be located in one and the same place, and such locality must, of necessity, be at very unequal lateral distances from the rooms to be warmed, with the hot-air conducting pipes of corresponding lengths. Rarified air has a tendency only to ascend and is incapable of being forced any distance in a horizontal direction, except through the application of some mechanical force. It will naturally rise through the first openings, hence the rooms nearest the source of heat, (the furnace,) are unduly hot, while those more remote may not be warmed at all. But if at times the distant rooms should receive a flow of heat, there is no certainty of their being thus favored again, as the force of such is so feeble, that some capricious current of air in the house, or some "ill wind" without, is sure to affect it. We lay it down as a positive rule, that to insure warmth

to any space, the source of such warmth must invariably be located directly beneath or within it.

Unequal heights, also, are unfavorable to the even distribution of heat. One warm-air duct terminating at a higher point than another will have the greater flow of heat, on the same principle that a tall chimney will draw better than its shorter neighbor. In hot-air furnaces two conditions unavoidably exist to create this inequality in the upward currents. One is the unnatural lightness, and consequent buoyancy of the highly heated air; the other is the one hot-air chamber supplying all of the warm air ducts. So, in addition to our rule respecting the lateral conduction of warmed air, the same equality of condition must be maintained in its vertical distribution.

They do not ventilate.—Although the force which the hot air rushing in exerts upon the air in the room may expel it through some apertures of egress, and thus effect a thorough *change*, yet this does not constitute *ventilation* in the true signification of the term. The air is made no *better* by the process, but rather *worse*. The comparatively pure air of the room is merely exchanged for that which is contaminated.

Their irregularity of fire.—Subject to the capricious judgment of domestics, and without any self-regulating contrivance to check excessive combustion, the fire is left to a wasteful and dangerous irregularity. When you require the least heat in your apartment, the servant has *considerately* raked out the grate, opened the draft, and put on a surplus of coal; but, when you really want heat, the draft-damper *happens* to be closed, and the fire clogged, and, for all the servant knows, it is a mystery why the fire does not burn better.

The closing of registers and excluding hot air from

the room, does not, as in the case of a well-constructed steam apparatus, have the effect to check the draft and deaden the fire, but rather to increase it, for the greater the heat against the furnace, the more the draft is accelerated and the hotter is the fire. With every means of escape closed, and a heavy fire raging, it may be readily seen that the air in the hot-air chamber and pipes leading therefrom would become dangerously hot; and, robbed of all its vitality, would, *in this instance at least*, become unfit for respiration.

The evaporating pan.—The evaporation of water from a vessel placed within the enclosure of the furnace, is but a poor remedy for the scorching of the air. The excessive and irregular evaporation, which is unavoidable, is frequently more objectionable than the overdried air. The moisture is only *mechanically* taken up by the currents of air that may *happen* to come in contact with the water. This does not reinstate the original vitality of the atmosphere, nor recompense it for the loss of its natural moisture. Papered walls and furniture are often injured, and even ruined, by excessive humidity from this source; and its effect upon our personal health is certainly a matter of serious moment. The visible deposit of vapor on the windows and walls in the kitchen, is an apposite example of the effects of excessive evaporation.

Improved Combinations.—A great diversity of patterns, and many wonderful “scientific” and “philosophical” applications and “combinations” are displayed in each quarterly edition of this *modus operandi* for creating artificial heat. Some adopt an apologetic attachment in the shape of a few feet of steam or hot-water radiators; others vaunt themselves of some “self-cleaning” “gas-consuming,” or “super-heated”

paraphernalia, but they all amount to one and the same thing, and are subject to the same objections. We lay it down as an incontrovertible law, which will meet the approval of every candid mind that has given the subject a thought, that *no apparatus is fit to create artificial warmth for human beings, whose air-warming surfaces are contiguous to the fire and its attendant gas, smoke, and dust.*

Remarks.—Such are a few of the many evils connected with the use of modern hot-air furnaces; and yet, because their first cost is small, they are more universally used, in America, than any other heater that sends its heat up from below. But their employment is peculiarly an *American institution*. Intelligent foreigners attribute our bad health and complexions to their use. It is to be sincerely hoped that as the public becomes enlightened on the subject of artificial warmth, and the laws of health relating thereto; and as less objectionable modes of heating are brought within its reach, this unnatural arrangement will be consigned forever to oblivion.

HOT-WATER FURNACES.

For want of proper knowledge in the adaptation of steam for warming purposes, especially for domestic use, the hot-water, or more properly the *warm-water* apparatus has been resorted to by many as a remedy for the evils of the hot-air furnace.

Their merits consist in their being directly opposite in all their features to the hot-air furnace; and their demerits are that these opposite features amount to *extremes*. Their sins are rather of omission than commission. The heat they yield—so far as it goes—is of an agreeable

and healthy kind. But the cold breath of winter does not agree with them, as the many inefficient members of this family now laid aside bear conclusive testimony. It has been properly styled "a warm-weather heater." The most approved patterns *do*, however, give heat enough *except* in very cold weather.

The hot-water apparatus is not of modern origin; it has been more or less in use almost from time immemorial. Its ancient usage was confined more particularly to green-houses, graperies, &c., &c. In this department it possesses some decided virtues. The warming surface in this case (usually consisting of four-inch cast-iron pipes) is placed directly within the space to be warmed, extending its entire length. The surface being ample, and the large body of water circulating freely through the pipes, an even temperature is maintained. This temperature can, by careful firing, with an ample supply of heating surface, be graduated to the requirements of most conditions of the external atmosphere. But this nicety of modification to any required temperature implies a skilful and ever-watchful gardener and fireman.

For warming private residences the pipes are generally smaller, and are located in the cellar, in the same position as the hot-air furnace. The air being but moderately heated, the pipes conducting it into the rooms are necessarily very large. The same necessity requires the heating surface to be very extensive, and consequently to occupy a large space, and involves a heavy expense in its construction.

Owing to a large body of water being heated, the apparatus is very slow in getting up its heat, but, as a partial recompense for this defect, it is equally slow in parting with it. Water is one of the best retainers or *bottlers-up* of heat, which fact argues against its effi-

ciency as a heating agent—at least against its *rapidity* of operation.

Liability of freezing.—One of the most serious objections against this mode of warming, is the constant liability to freeze. So long as the whole body of water in the pipes is kept in circulation, this cannot, of course, occur. But the fire, which disturbs the equality of temperature in the water and causes it to circulate, is liable, through neglect or otherwise, to go out. Or if the fire be quite low, it may not cause a circulation, owing to the friction of water against the immense surface. The water always remaining in the pipes, and often remote from the fire—its exposedness to the out-door inclemency by means of a large cold-air box—the force with which the inward current is impelled against the pipes—these circumstances combine to increase the liability of the water to congeal.

There is usually a damper in the cold-air box by which the out-door cold may be excluded, but its adjustment depends upon the servant, who, if careless enough to neglect the fire, would certainly fail to attend to this.

The high-pressure form of water furnace.—This is an arrangement whereby the heating pipes run through the house and are coiled directly within the various apartments to be warmed. It is the invention of Mr. Perkins, formerly of Massachusetts, but now of London, England. It is now nearly obsolete in the United States, although it was once adopted here to a limited extent. Some of the apparatus of Mr. Perkins are made to operate under a pressure of four thousand lbs. to the square inch. This plan possesses all the objectionable features of the other, with some additional ones.

Its liability to freeze is not as great, but the results are more disastrous. Where the pipes run to any considerable height, the hydraulic pressure on the lower part of the apparatus is very great; this, with the amount of expansion and contraction by heating and cooling of long lengths of pipe, creates a liability of leakage from the numerous joints, stop-valves, &c., which in nice rooms would be inadmissible. Such a large volume of water, extending, as it does, from cellar to garret, would, in a case of breakage, flood the house and furniture to their ruin.

No ventilation is produced by this system; and the coils in the rooms have to be covered by screens which take up valuable space and are not very ornamental.

Inequality of temperature of warm-water heating surfaces.—As the water in the tubes may have a graduation in its temperature, all the way from 32° the freezing point, to 212° the boiling point, it is impossible for it to maintain an effective heating surface against the ever-changing temperature of the out-door air which is drawn against it to be heated. We have in another place given a rule that the temperature of the surface against which air is to be warmed should hold the same against whatever change that air may be subject to, and the correctness of this rule we think must be obvious to all who have given the subject any thought. The cutting properties of an instrument become diminished as its edge is impaired; so with warm-water warming surfaces, the cold breath of winter blows over them, blunts their heating force—and a cold house and a cold day come together. Water may be any where in the scale of temperature from tepid or luke-warmth to boiling, and be warm or hot water still; while steam (as an opposite example) cannot exist at a lower temperature than 212° —a very

effectual heating point. Even with the heating surface abundant, and the fire in good condition, the cold air will lower the temperature of the pipes to a very ineffectual point, and these conditions may be less favorable to an extent to admit of freezing, even while the water is travelling on its sluggish course. But steam apparatus with boilers properly proportioned to the heating pipes, keeps them fully supplied with steam, and the temperature of the surfaces is not at all diminished, let the air that comes against them be as it may.

Heat given off to no purpose.—Water being an excellent retainer of heat, as indicated by the long time required after the fire is built to make the heat available, and, consequently, equally tardy in parting with it, there is a decided loss in warming school-houses, churches, stores, and all places where warmth is required only a limited portion of the time.

For instance, a building requires warming but six hours out of the twenty-four; to do that with a water apparatus the fire must be built eight hours before the building is used. Now a good steam apparatus (a part of whose small body of water is converted into steam (212°) in a few minutes) is capable of warming the apartments sufficiently in two hours; consequently, it has but two hours to give off its heat to no account when the fire is allowed to go out, and warmth is not required; while water, with an excess of six hours in the commencement, has the same length of time (six hours) to waste its heat. This feature in the water apparatus, together with the lack of self-control to the fire, accounts for its extravagant consumption of fuel.

Its principal merits consist in the opposite conditions to hot-air furnaces in respect to extent and temperature of the heating surfaces.

The mongrel form of water furnace is a combination of surfaces heated by hot water, steam, and the fire itself. In some arrangements the last-named agent predominates; in others, the second. In one instance the air to be warmed, after passing over the red-hot surfaces of the hot-air part, is cooled or *tempered* against a meagre amount of water or steam surface; in another, it more properly passes *first* over the water surfaces, and afterwards over the steam surfaces.

Another contrivance is, sections of cast-iron hexagonal-shaped flues, stacked together directly over the fire. Within these flues are sometimes placed strips of thin sheet iron, with a view of conducting the heat more rapidly from the *actual* heating surfaces. This apparatus has a steam chamber, blow-off valve, etc., and would more properly come under the head of steam heating. The air is drawn simultaneously over steam and water surfaces, and then against the bricks by which the whole is enclosed. The air warmed by this process is mixed up with a deleterious compound of water-heat, steam-heat, and smoke, ashes, gas, and other poisonous resultants of leakages from the fire-pot and fire-chamber. This system, besides its similarity to the hot-air furnace in collecting within its heating compartments the residuums of ordinary combustion, possesses a more dangerous feature in its confined steam than any steam apparatus now before the public. But so long as it goes under the pacific cognomen of "hot-water furnace," its true character will not be generally understood.

The evils of locating heating surfaces contiguous to the fire are most apparent. As we stated, in speaking of hot-air furnaces, the partition dividing the fire from the hot-air chamber will unavoidably become warped and broken. Whether it consists of brick, stone, or iron,

the continuous action and reaction of excessive heat will soon break the joinings sufficiently to allow the escapement of gas, smoke, and ashes from the fire, to find their way into the hot-air chamber.

This evil exists to an inadmissible extent in nearly every heating apparatus yet erected, and is particularly flagrant in the above-named device. We think every intelligent mind will coincide with us on this point—that *even the liability* of leakages from the fire into the air we are expected to breathe, should not exist.

In point of durability, the water apparatus is defective when its heating surfaces consist of cast-iron tubes or sections. This is owing to the impracticability in foundries of casting even thickness in “core work.” The adjustment of “cores” for a great number of pieces, especially if they are of considerable length, and the maintenance of their positions during the process of casting, may be laid down as one of the impossibilities of the trade. Even should the core remain in its place, the fused metal in the progress of pouring and cooling must, from well known practical reasons, attain an inequality both in surface and texture. Thus alternately thick and thin, soft and hard spots will occur in this species of foundry work.

Tubes, or other cast-iron devices for heating purposes, are usually put together with cement, lead, cloth, India-rubber packings, or some oxydizing preparations. Through the constant strain caused by heating and cooling, expanding and contracting, these joints will, sooner or later, become broken, or some of the more brittle portions of the surfaces themselves will crack, and leakage is the inevitable result.

Miscellaneous objections.—By using a large quantity of water, with no provision for drawing it off, sediment

and mineral deposits will accumulate, and gradually impair the efficiency of water-warming tubes.

The very large amount of heating surface which they present to the air, is objectionable from the dust and refuse matter continually accumulating thereon.

Hot-water operators find it impossible to keep the water just at its boiling and most available point, without its escaping in steam or overflowing; and the control of the draft to the fire in conformity with the heat required, has not yet been accomplished by them.

Experience does not prove that any form of hot-water apparatus is other than wasteful in the consumption of fuel.

LOW-PRESSURE STEAM HEATING.

It is acknowledged by all those who are acquainted with the nature of steam, that it is at once the most efficient, manageable, and economical of all agents for communicating and distributing artificial warmth. It occupies the same superiority of position in the heating department that illuminating gas does in the department of artificial light. Being of about the specific gravity of gas, and of an elastic and volatile nature, it is peculiarly calculated to flow to the desired point, even through long and circuituous sections of small pipes. It expands seventeen hundred fold over the bulk of water from which it is generated, and, in returning to water, imparts one thousand degrees of heat to the air, which in water and in an uncondensed state would be latent and unavailable. It admits of the most compact form, both as regards the space occupied for its generation, and the surface to heat the air.

To construct a steam apparatus that shall be efficient, reliable in mechanical detail, and at the same time simple, substantial, economical, healthful, and perfectly safe, even in the hands of a common domestic—this is the great desideratum.

COST OF CONSTRUCTION.

A proper low-pressure steam apparatus cannot, if constructed of material of suitable durability, compete

in point of *first expense*, with hot-air furnaces, high steam, or any form of warming where a small amount of surface (*by being over-heated*) is rendered capable of warming a large amount of air.

Where the temperature of the heating surface (which surface is the principal item of expense) is limited to a low and healthy quality, of course a larger quantity must be furnished than where the surface is heated to a much higher degree. The expense in the latter instance is *materially* lessened at the expense of health and safety. The same principle applies to the boiler that generates the steam.

If it be stinted in size and of small capacity, it will require frequent attention, be extravagant in the consumption of fuel, and furnish an irregular and unreliable quantity of steam. But in comparison with hot-water, or any apparatus which has a *superfluous* amount of heating surface—surface whose temperature is unwarrantably *below* the healthy point—the low-pressure plan can “under-bid”—the same space to be warmed, and all other things being equal.

SAFETY FROM EXPLOSION

To those not conversant with steam and its adaptability to domestic warming, the question naturally arises as to its safety when thus applied. The idea of “*explosion*” is invariably associated with the mention of steam boilers. In every instance where an explosion has occurred, steam was confined under a very heavy pressure; a large quantity was in the boiler, and that, for want of water, in immediate contact with an immense red-hot generating surface, with a fierce fire raging at the same time. With a proper low-pressure

apparatus, there will be, *at all times, a directly opposite condition of things.* Instead of steam being under the pressure of 50, 75, or 100 lbs. per square inch, its highest possible pressure will not exceed one-tenth of the lowest of these figures, while every part of the apparatus is capable of sustaining a pressure of twice the amount of the highest figures. Instead of there being, for example, a million volumes of steam on hand at any time, one hundred would be the excess. Instead of the fire being driven to its highest pitch of intensity (but lowest point of economy) with a rapid draft, it burns very slowly, to a degree, and with a draft just sufficient to insure perfect and economical combustion.

To supply water to the boiler requires no more care and skill than to the tea-kettle on the range, and its neglect would involve no more disastrous results.

But should a "bursting" happen at this low pressure, its consequences, compared with high steam, would be about as serious as the bursting of a pop-gun compared with that of a heavy piece of ordnance.

Steam, in the proper form for warming purposes, is even less dangerous than common illuminating gas. During eight years of constant experience in applying steam to private dwellings for warming purposes, and out of some three hundred instances where steam has been thus applied, the author has not known of a single accident from explosion, fire, or otherwise, where personal safety was at stake. Who can say as much of gas—not mentioning camphene, burning-fluid, and other dangerous substitutes? (See remarks on high steam, page 35.)

SAFETY FROM FIRE.

There is a prevalent ignorance on this subject, even among men whose official positions ought to lead them

to more extensive information. We will admit that steam has been known to set fire to buildings—water has done the same under like conditions. It is not the *kind* of apparatus, whether hot-air, hot-water, steam, or any other thing, that involves a dangerous condition from fire, but the *quantity* of caloric or heat with such apparatus or thing evolves. *Ice*, could it be heated to an equal temperature, would ignite whatever it came in contact with as readily as a red-hot iron bar. It is the *temperature* of the surface, let it be what it may, that implies danger from fire. That temperature, in the use of steam, generally depends upon the *pressure* which the pipes or radiators sustain, their thickness, the kind of material of which they are constructed, &c., &c. Yet pressure is not *always* necessary to produce high temperature in steam; by superheating, it may be increased to almost any extent. Steam in its native and unconfined state, is a most effectual agent for *extinguishing* fire.

The following table shows, in round numbers, the temperature of steam under different pressures:—

At the natural pressure of the atmosphere					212°
boiling point,					
At	1 lb.	pressure above do.			212°
"	5 lbs.	"	"	"	228°
"	10	"	"	"	241°
"	15	"	(The limit of a healthy temperature for any heating surface.)		251°
"	20	"	"	"	260°
"	25	"	"	"	269°
"	30	"	"	"	276°
"	35	"	"	"	283°
"	40	"	"	"	289°
"	45	"	"	"	295°

At	50 lbs.	pressure above		301°
"	55	"	"	306°
"	60	"	"	311°
"	65	"	"	315°
"	70	"	Bread bakes and wood scratches.	320°
"	75	"	"	324°
"	80	"	"	328°
"	85	"	"	332°
"	90	"	"	335°
"	95	"	"	339°
"	100	"	"	342°

Thus it will be seen that the danger from fire in the use of steam depends altogether upon the temperature of the pipes in which it is confined, and that temperature (in common use) depends upon the *amount* of pressure of steam in those pipes. We can refer to a thousand instances where pipes containing low-pressure steam are run in every point of contact with wood, shavings, paper, and the most inflammable substances, and, after many years' use in such positions, they have not yet caused even "the smell of fire." The Board of Fire Insurance Companies of New York has recently decided this question in favor of low-pressure steam, and agrees to make a deduction of ten per cent. on all risks where it is exclusively employed for warming.

SELF-REGULATION.

This is the most important feature in the construction of a proper warming apparatus. All of the most common artificial heaters of the present day are without any such arrangement, and are unable to have it, for want of some available mechanical force. Steam is peculiarly calculated to effect this object, as the small amount of power requisite is easily applied, by a very

simple mechanical contrivance, to shut off and reverse the draught to the fire, and to prevent any possible accumulation of steam beyond the desired limit, even more perfectly than an intelligent being, constantly in attendance, could possibly do.

It is evident that the fire should burn, and the fuel be consumed, only in proportion as heat is required. The quantity of heat thrown off from the heating surface depends upon the quantity of steam it condenses; and the extent of this condensation depends entirely upon the amount and temperature of the air coming in contact with the surface to be warmed. Thus, when a large amount of cold air is brought against the heating or radiating surface, the condensation is rapid, a large quantity of heat is evolved, the steam used fast, the pressure diminished, the draft opened, and the consumption of fuel increased. On the other hand, if the air to be warmed is taken against the surface at a higher temperature, or the quantity diminished by its ingress being shut off from any room, the condensation is diminished, less steam is used, the pressure increased, the draft closed, and the fire checked to any given requirement.

By this arrangement, it will be seen that steam is the agent for the regulation of the fire that generates it. This is all-important, as the fire is the prime mover, and no steam or heat can exist without it. On this feature depend safety, economy in fuel, general convenience and healthfulness. Without it no apparatus is complete, and no *steam* apparatus admissible. The mechanical construction of such an arrangement must needs be of the most simple, substantial, and reliable kind, and proof against any contingency.

ECONOMY IN FUEL.

A perfect regulation and control of the draft, causing the fire to burn *only* as the demand for heat is required, and invariably checking it when that demand is met; the water from the condensed steam, still hot, running back by its own gravity to the boiler, being constantly re-converted into steam, with only an incidental waste—and, consequently, not drawing upon the fire to heat cold water;—the proper construction of the boiler to insure the most perfect combustion, and a full absorption of the caloric of the fuel in the generation of steam—are the principal conditions on which the consumption of fuel depend, and these are all maintained in this apparatus to a degree of economy not equalled by any other.

By practical experience, the author is convinced that in the use of a properly constructed low-pressure apparatus, under like circumstances, only one-half the amount of fuel will be consumed that would be by a common hot-air furnace, and nearly the same ratio will hold good in comparison with hot water and high steam.

LIABILITY TO FREEZE.

This evil, which is such a serious one in the use of the hot-water apparatus, scarcely exists in this. Steam, of course, cannot congeal, and the water resulting from condensation, running back to the boiler through warm pipes, certainly will not. But should the cold air duct be left open, the fire being nearly out, and only steam enough made to *partially* fill the exposed surfaces, the frost will get the ascendancy to such an extent as to congeal the water resulting from condensation before it can make its way back to the boiler.

Therefore the draft of air through our cold-air duct to the heating surface is regulated by a damper operated by the pressure of steam, and is proportionate to the amount required to be heated, and the capacity of the surface at the time for heating the air. Whenever the fire and steam go down, this damper will be invariably closed, and the cold external air shut off from the heating surface. If but a part of the surface is filled with steam, or the ingress of warmed air into the room is stopped by the closing of registers, a corresponding amount of air will be admitted. Thus it will be seen that this arrangement not only secures an even temperature to the air warmed, but prevents the liability of freezing from this source.

QUICKNESS OF OPERATION, AND STEADINESS OF HEAT.

Having but a small quantity of water to heat, and a large fire-surface wherewith to heat it, steam is quickly generated and distributed through the heating surface. From fifteen to twenty minutes usually will suffice "to get up steam" and make the heat available.

These conditions also insure a steadiness of heat. By an ample fire-surface against a small body of water, the fuel is enabled, by burning at its *very lowest point of combustion*, to keep up the required head of steam; and this point is maintained by the control of the draft over the fire. Thus steam, and consequently heat, is kept up so long as there is any fire.

In this particular it has been claimed that the hot-water furnace is peculiarly meritorious, especially for green-houses (though we do not admit that steadiness of heat and equality of temperature are more essential to the well-being of plants than they are to persons); that

having a large body of water, it maintains its heat a long while after the fire goes out. This is true; but if it maintains it a long while after the fire goes out, it *retains* it equally long when the fire is first built. On the other hand, steam is generated with the kindling of the fire, and goes down when the fire goes out. In this respect we claim a superiority for steam, for it is usually most desirable to have heat when the fire is built, and to dispense with it whenever the fire burns away, or is extinguished. Both systems create heat equally while the fire is burning, but the difference is at the *start* and at the *terminus*. One withholds it from being available at first, to give it off leisurely after the other has accomplished its duty. In the *aggregate* both systems evolve the same amount of heat under like conditions. The difference is only a matter of *time*.

FREEDOM FROM NOISE.

In the high-pressure form of heating, the noise occasioned by the collision of condensed water and steam being driven against each other, is very objectionable. The sound resembles the tapping of a hammer, and is continually kept up where long lengths of small lateral pipes are employed. In factories, workshops, and on steamboats, this noise may be admissible, but in private dwellings, schools, &c., never. Iron pipes, especially large ones, run to the different rooms of a dwelling, are objectionable in being such good conductors of sound. The least rattle of coal or other noises at the boiler, can be heard quite as distinctly in some distant room as where it occurred. Neither of these undesirable features exists in this plan. The pipes are so arranged, and of sufficient size, and the pressure in them so slight, that

the flow of the steam upwards, and of water downwards, is free and noiseless.

SIMPLICITY AND EASE OF MANAGEMENT.

To have a heating apparatus—especially one that otherwise would be dangerous—simple and substantial in its construction, not liable to get out of repair, and entirely secure in the care of common domestics, is indispensably essential. This apparatus combines these necessary features. The fire requires to be fed, to keep up an even supply of heat, but twice in twenty-four hours. A fresh fire will seldom need to be built.

There are usually no valves whose adjustment depends upon the care and judgment of any one. Only the simple and all-important items of fuel and water are required to be supplied. The supplying of these *must*, under any circumstances, rely upon human intelligence. No contrivance, though it be as perfect as mechanical skill can construct, is *infallible*, therefore none should be intrusted to fulfil this indispensable duty. The habit of the common domestic in the kitchen, of supplying with punctilious regularity, every morning, the water to the tea-kettle, and the fuel to the stove, amply qualifies her to attend to this duty—no more skill, judgment, or trouble is required in one case than in the other.

The simple act of shutting off or letting on the heat, by turning the registers, whenever agreeable to the occupants of any part of the house, does, of itself, regulate the fire, the accumulation of steam, and the amount of air to be warmed, as before explained.

DURABILITY.

Where a considerable expense, as well as some trouble is involved, we want, besides the assertion of

“for value received,” some other *assurance* of durability, and that what we buy will, besides *appearing* all right, be in reality of some *lasting* benefit. This is particularly desirable in a heating apparatus which is put into a private dwelling. Outside of the first cost, its erection is attended with more or less inconvenience and annoyance to the inmates. Some tearing away, altering and repairing of wood-work, brick, stone, &c., is also implied in the operation.

The simple fact that this apparatus is capable, in all its parts, of sustaining a pressure of two hundred pounds to every square inch, must be proof abundant and apparent of its durability. In short, the boiler, heating surface, and all the appurtenances connected, will last and hold good at least the average life-time of man.

HIGH-PRESSURE STEAM-HEATING.

We will briefly speak, by way of comparison, of a system of steam-heating which is directly opposite in all its features to the one we have been considering.

Most persons have but a superficial knowledge of steam, and of course are ignorant of its different forms of application, both as an agent for heating purposes and as a motive power. All are familiar with the sight of the long lengths of small pipes running beneath the seats of steamboats, and around the rooms of factories and many other large buildings. This is the high-pressure application of steam-heating, and has been in vogue for a great many years.

The steam is generally supplied to these pipes from

the same boiler that furnishes steam to drive the engine, and they are subject to the same heavy pressure. This plan is a convenient one where a steam engine is required, but the objections to it make it hardly admissible under other circumstances.

Disagreeable Noise.—The pipes, sustaining a high pressure, usually about fifty lbs. per square inch, and extending long distances in a level position, are liable to a constant noise resembling the tap of a hammer on the pipes. This disagreeable sound is caused by the steam coming in contact with the condensed water in the pipes, and which must be forced forward by the pressure of steam, as the horizontal position of the pipes will not admit of its running off by its own gravity.

Health and Appearance.—The temperature of the pipes, under this pressure, is too high (300°) for a healthy and agreeable heat. The dust settles upon them and becomes burned, which, with the heating over and over again of the air of the room that is inhabited, occasions an offensive and unhealthy effluvia.

The pipes are sometimes stacked up in short lengths, and covered with an iron screen, mounted by a marble slab. This is the customary mode in stores and hotels. The naked pipes, as well as the common clumsy patterns of screens, would have an objectionable appearance in private apartments.

The Consumption of Fuel is much greater in a high pressure than in a low-pressure apparatus. Both philosophy and practice prove that in proportion as the pressure of steam is increased, the ratio of fuel required to give a certain amount of heat is increased, and *vice versa*. The *sensible heat*—the temperature of the heating surface—may be increased, while the *latent heat*—the great available principle in steam as a heat-

ing agent—is diminished. The amount of steam *compressed* in one instance, and the amount of steam *condensed* in the other, are relied upon for heating power.

Pressure involves fire, and fire fuel. The greater the pressure the less the quantity of available heat in proportion to the fuel consumed. In proof of this position we would refer to two buildings in New York, in both of which steam is employed to warm about 700,000 cubic feet of space. In one, the apparatus never exceeded 2 lbs. pressure to the square inch, in the other the pressure ranged about 60 lbs.

The amount of coal consumed during the same length of time (one season), with the other things being about equal, was one-half less in the low-pressure apparatus (70 tons) than the high-pressure (140 tons). We do not refer to this as a fair experimental example, as there were qualifying conditions, such as the more perfect regulation of the draft, &c., &c., in favor of the low-pressure apparatus; yet a fair test, under equally favorable circumstances, will prove the above comparison nearly correct.

Attention Required.—The supply of water must be maintained by the use of a power-pump, to force the water into the boiler against the pressure of steam. The constant watchfulness of an engineer is demanded to attend to this, and to keep the fire fed with fuel. The valves, also, in the different return-pipes of the boiler, need to be opened to ventilate the heating-pipes of air, and shut when the air is out, to prevent the steam from escaping.

Smallness of Boiler.—Here is a universal and most serious evil in the erection of the high-pressure apparatus. The fire-surface being too small, the deficiency must be made up in the *intensity* of the fire. With the

very strong draft necessary, the combustion is hurried, and consequently there is a large escape of partially consumed fuel up the chimney. But with boiler capacity sufficiently large to admit of slow and perfect combustion making the requisite amount of steam, the unconsumed particles, which in the other instance are lost, would be retained and burned, thus saving fuel, the labor of putting it on, and lessening danger.

The intensity of the fire, and the rapid generation of steam, impair the boiler by throwing off the water from the fire-surface immediately contiguous to the fire, and exposing those parts, thus rendering them liable to burn.

The smaller the boiler, the less the cost of construction. The expense of the boiler is economized by the man who erects it, at the expense of the man who is obliged to furnish fuel for it.

The Danger of Explosion is probably owing to an instantaneous accumulation of vast volumes of steam shut within the boiler. When explosions occur the water is usually so low as to leave unprotected considerable portions of the fire-surface; usually those portions acted upon most directly by the fire. Thus the steam becomes highly surcharged with heat by the fierce fire burning at the time. While these conditions exist, the pump driven by the steam, and of course increased in velocity in proportion to the increased pressure, is set to feeding more water into the boiler; the result is an explosion caused by the instantaneous flashing into steam of a large amount of water thus rapidly thrown upon the bare red-hot surfaces, and into the thus highly surcharged steam.

It will be readily seen that this state of things can never exist in our low-pressure system used for heating alone, as the water is fed into our boiler by the small steady force only of public water-works when available, or

the pressure from a tank or cistern, and this only through the small aperture of a one-half inch pipe. An *excess* of pressure, merely, would cause a bursting at the weakest point, and the pressure thus being relieved, nothing more serious would result.

The danger from fire in this system is owing to the liberation of the heat of a large amount of steam concentrated by heavy pressure, as more fully explained in speaking of the same subject in the use of low pressure steam, page 27. Many valuable buildings have been fired by the high pressure steam apparatus used in them; this fact in itself should constitute a sufficient objection to the use of this kind of apparatus for heating purposes.

VENTILATION.

The vast aërial space that surrounds our globe, and in which man, beast, and vegetation exist, is but a magnificent room whose floor is the earth, and whose ceiling the blue vaulted heavens. Here the wise Creator has provided the most ample ventilation.

The heat of the tropical sun, rarefying the air and causing it to ascend, while the cold air from the polar regions moves to supply the vacuum; the alternating temperatures of the different climates, the inequalities of the earth's surface and the ever-varying state of the atmosphere in respect to humidity, all tend to keep this mighty ocean of air in motion; while evaporation, absorption, and the various chemical changes constantly going on in the vegetable and mineral kingdoms, correct the universal decomposition and corruption which surround us, and to which man and all things are inevitably tending.

Thus the *Breath of Life* is perpetually changing, being renewed and purified by the benign economy of God in the operations of nature; and it is the imperative duty of

man to see that the same purity of air is permitted to exist in the artificial habitations he may construct, as in the broad expanse of space. To effect this object much labor has been spent, and many ingenious plans devised. Some have been successful to a certain extent, but most of them have failed of attaining the desired object, by being too complicated, expensive, &c.

Impurities to which we are subject.—The principal sources of impurities from which in-door air requires to be freed by ventilation, may be briefly summed up as follows :

1. Expiration from the lungs of persons and animals.
2. Perspiration (sensible and insensible) from persons and animals.
3. Stoves of all kinds
4. Hot-air furnaces.
5. Fumes and vapors from the kitchen.
6. Artificial illumination.
7. Unnatural dryness of the air.
8. Unnatural humidity of the air.
9. Evaporation from human and other bodies.
10. Decomposition of organic substances.
11. Stagnant air.
12. Damps of cellars and basements.
13. Sickness, fumes of medicine, &c.

The extent to which these impurities exist under an innumerable variety of conditions and contingencies, and in different localities, we will not attempt to define.

The amount of provision requisite to be made for counteracting the pernicious effects of the above-named causes, depends altogether upon the necessity existing in each individual instance. In hospitals, school-houses, public buildings, and all places where a large number of persons are congregated, the contamination of air is very great, and corresponding provision should be made for ventilation.

In private houses where but few reside, and where few sources of contamination exist, less effective means are required to ensure proper ventilation. The remedy must in all cases be commensurate with the requirements, and this must, in a great measure, be left to the good sense of those whom it immediately concerns.

Merely changing the air does not constitute ventilation. The air may be often changed and still be more impure than in a stagnant or otherwise perverted state. Hot-air furnaces give a copious change of air to the apartments, and their venders are loud in proclaiming the importance of ventilation, making a virtue of necessity, to effect the sale of their wares. The remedy is worse than the disease in this case. The heated, gaseous air thrown up from the furnace is most unhealthy, while the air it displaces in the room is comparatively pure. A *change* in the air is effected, but *ventilation* is prevented.

Equal temperature necessary. The air of a room may be changed, and all its impurities be removed, and it still be in an unhealthy condition from an uneven temperature. A cold current may be circulating through it in one part, and a warm current in another. The tendency of all artificial heat is favorable to this evil. Heated air naturally rises, and the upper strata in an apartment will be warmer than the lower, unless counteracted by some artificial process.

Very much depends upon the condition of the air warmed, whether it be deprived of its natural moisture, and thus rendered specifically lighter, or warmed merely without interfering with its natural state. The heat from hot-air furnaces and stoves is, of all others, the least calculated to distribute itself in an apartment. Besides, the air being deprived of its moisture by coming in contact with over-heated surfaces, the gases are deranged, and its natural gravity thus lessened.

THE NECESSITY FOR VENTILATION IN PRIVATE HOUSES.

Here the principal contaminating influences to provide against, are those which emanate from the human system, and from artificial heating and illumination. Taking the average opinions of the best authorities, a common grown person will vitiate and render unfit for respiration 7 cubic ft. of air per minute.

The natural causes of impurity from the human system are :

Consumption of oxygen (the vital element of the air) by inspiration; emitting carbonic acid by expiration; insensible perspiration; and "the peculiar effluvia of the living body."

Thus a single person would, in 6 hours, destroy the air contained in a room 16 ft. square and 10 ft. high.

But we ought not to limit our lungs to the smallest amount of pure air which the constitution can tolerate without perceptible injury. "It is evident that the nearer the air within-doors approaches in purity and freshness the free and open atmosphere, the better will it conduce to health, strength, and length of life." To maintain the highest state of health through our respiratory organs, the air with which we come in contact at one moment, should be exchanged for fresh air the next. It should instantly be carried off and as often renewed. With every inspiration of the lungs we irrecoverably take from the air a portion of its vitality; with every expiration we actually poison it.

A candle (6 to the lb.) will consume one-third of the oxygen from 10 cubic feet of air per hour. Oil lamps with large burners will change in the same way 70 ft. per hour. Gas illumination produces the greatest

changes in proportion to the light evolved. Every cubic foot of gas burned imparts to the atmosphere one cubic foot of carbonic acid. A burner which consumes four cubic ft. of gas per hour, spoils the breathing qualities of 400 cubic ft. of air in that time.—YOUNG.

The injurious consequences of foul air. By breathing foul air, almost every species of diseases is engendered; among the first of which are cholera, consumption, fevers, scrofula, and all the various difficulties of the lungs and throat, and infant mortality. It disorders and prostrates the physical constitution generally, and has a degrading and debilitating influence upon the *mental and moral* faculties.

Therefore it is not possible to obtain *too much* fresh air, though to obtain a large amount properly warmed, in cold weather, is a matter of serious if not *expensive* consideration.

The *modus operandi* whereby to effect the desired change, purity, and even distribution of air artificially warmed, must be taken into consideration. On the principle that "like cures like" we must employ some artificial process as a remedy. It would be futile to attempt to define any particular process of ventilation which would be applicable in all cases.

As heated air has a tendency to ascend, vents or escape-pipes should, in ordinary cases, be provided near the floor. This will counteract the rising current, by creating a downward draft. The heaviest and most noxious gases floating in the lower part of the room are also drawn off. Other vents should be provided near the ceiling, for summer use, in connection with the lower ones.

As artificial ventilation involves motion of air produced either by heat or some mechanical force, artificial

heat, by being constantly in domestic use, is the most economical and available agent; and a proper warming apparatus becomes a convenient and important auxiliary, and may be arranged to perform both duties satisfactorily.

Artificial Ventilation and Cooling in Summer Time.—When the public become more convinced of the importance of proper ventilation, and are willing to be at the *expense* of pure air instead of lavishing money on useless decorations, we may expect to see, in common use, artificial appliances for a more thorough and steady change of air in warm weather.

This can be effectually and safely accomplished by rarefying a shaft of air leading from the various rooms to be ventilated, by means of steam-heated surfaces placed in a ventilating dome on the roof, or in a chamber in the garret, through either of which the shaft or shafts may find an external opening to the outer atmosphere. Or a cheaper, if not more effectual mode, is to have *double chimney flues*, by enlarging the common kitchen flue sufficiently to admit an interior one to be used exclusively for the smoke and products of combustion. Into the outer flue, vents may be opened from all the different rooms, and the ordinary fire used for cooking and laundry purposes will rarefy the air and create a good draft. To accelerate the draft, and increase the power of ventilation, the additional heating surfaces, as in the former arrangement, may be applied. Of course these vents from the rooms must have corresponding inlets from out-doors, which are provided in the flues, that, in cold weather, bring the warm air into the rooms from the heating apparatus.

Adopting either of these plans would obviate the necessity of opening windows and doors, which let in dust

and noise, and unpleasant odor from the streets, and which are so convenient for burglars. It would also prevent the unequal currents of air from those openings, and insure a regular change, whether the out-door atmosphere be in motion or not. The air to be drawn through a room may be cooled to any extent by causing it to pass over ice ; it may also be purified by being filtered through charcoal. Both of these operations are practical.

Ventilation involves Expense.—The real practical difficulty in ventilation is its cost. Although the atmosphere is everybody's property, and is the cheapest of all things, yet a supply of pure air in dwellings is by no means free of expense. To insure ventilation we must have motion of air, and to produce motion demands force, which is a marketable commodity. Whatever will produce available force has value in it. Whether it be fans and pumps driven by steam-engines, or upward currents set in motion by naked fire, in both cases there is expenditure of fuel. It is true we may use the fire that must be kindled to produce warmth, and thus secure the additional result of ventilation, apparently without an additional cost. But in most cases foul air is also warm air, and in escaping conveys away its heat, which is thus lost. Contrivances have been proposed by which the out-flowing warm air may be made to impart its heat to the in-coming cold air, but they are not yet reduced to practice. Until this is done heat must continue to be lost by ventilation just in proportion to the extent. Hence, as was before remarked, ventilation may be classed with food and apparel, and it becomes a question of how much can be afforded. But there is this important difference, that while economy in the latter—a plain table and coarse clothing—are at least equally fa-

vorable to health, with more expensive styles of eating and dressing, economy of ventilation, on the contrary, that is, any cheapening or deterioration of the vital medium of breathing, is injurious to health. One of the worst evils of scarce and expensive fuel is, that the poorer classes feel compelled to keep their rooms as tight as possible, to prevent the escape of warm air and the consequent waste of heat.—*Youmans*.

RADIANT HEAT.

Air and objects are warmed from sources of heat by convection, conduction, radiation, and secondarily by reflection. All heat that is to any extent effective in yielding us that warmth which we require in addition to the inherent heat of our bodies, is through the first-named means.

All contrivances in vogue for creating in-door warmth, warm us principally through the air first being brought by circulation in actual contact with their heating surfaces (convection).

The extent to which heated surfaces radiate depends, practically speaking, upon the temperature of such surfaces. A bed of red-hot coals, as in the open fire, is the most powerful radiator in domestic use. This is due, not only to their high temperature ($1,200^{\circ}$ to $2,000^{\circ}$), but to the multiplicity of angles of radiation which the variously shaped pieces of coal present. But the radiation from this, the most powerful of radiators, is, as we all know, quite small, and the quantity of fuel consumed, compared with the amount of heat afforded, enormous. Some investigators estimate that as much as fourteen-fifteenths of the heat set free by combustion escapes up the chimney, and is lost.

The ordinary fire-place at one side of the room is a

good example of the extent to which radiant heat is available for heating purposes: for here, owing to the draft up chimney, all the heat yielded by conduction and convection is lost, and all the heat distributed in the apartment is through radiation. Ten feet distant and within the direct line of its rays, is as far as we can expect to receive any beneficial effect from this source. Surfaces of a lower temperature would be proportionably ineffectual.

The heat-rays from a steam heated surface at 200° could hardly be detected at a distance of two feet. In fact, were a strong current of air passing over such surfaces and up chimney, as in the open fire-place, freezing might occur within a few feet of them.

The heat we get from a steam radiator, as before stated, is from *convection*—the circulation of air against it. In proof of this, we have found that, in actual practice, a room is quite as well warmed, as otherwise, with the front of the radiator screened, and all extension of rays prevented, sufficient space, of course, being provided for the circulation of air beneath.

The *theory* of radiation, as put forth by some very learned but very *unpractical savans*—that rooms are warmed by rays from steam radiators as the earth is warmed by rays from the sun, is very fine; but in practice we would be very liable to suffer with cold, notwithstanding this benign result. “It is believed that the sun’s rays do not heat the regions of space, and the earth’s atmosphere is heated almost entirely by contact with the surface of the heated earth.”—*Silliman’s Chemistry, revised edition, page 57.*

Radiant heat alone is objectionable in a sanitary point of view, from the great inequality of temperature at different distances from the source. “The intensity

of radiating heat (like light) is only one-fourth as great at a double distance."—*Arnott*. Thus taking the temperature at one foot distant from the radiator to be 80° , at two feet it would be 20° , at four feet 5° , and so on in an inverse ratio.

Rays of heat warm only that part of an object that comes within their direct range. In facing a radiator the face is heated while the back is cold. "The difference is exactly like that between being in the shade and in the sun." We cannot endure the direct rays of the summer's sun, but when we are protected from them, and are within the genial influences of warmed air, that affects every part of us alike, no better condition of warmth could be desired.

To have a room and its occupants evenly warmed by artificial radiation alone, it would be necessary to have the entire walls, ceiling, and floor, covered with heating surfaces, that the rays diverging from them may equalize the temperature, and strike every part of the person at the same time.

MISCELLANEOUS REMARKS.

There is at the present time a general dearth of good artificial heaters. Steam, as the agent for heating, is rapidly growing in public favor, and must eventually supersede all other modes, although it is, as yet, only in the incipient stages of development. The field is so broad and inviting that ambitious adventurers are plenty, each sanguine of ultimate success in attaining the much-desired object, viz., the construction of a *cheap* and *perfect* steam apparatus. Most of them are entirely successful in obtaining the *former quality*, but fall lamentably below the standard in the *latter*. Many are the devices concocted within prolific brains to effect this object, and most as frequently is recorded the untimely birth of some alien to the legitimate household of heaters. Happily however, for the public, they seldom attain any further state of development.

Steam for mechanical applications, and steam for warming purposes, do not go hand in hand. The offices of one disqualifies it for the proper duties of the other, and *vice versa*. Theory, practice, and philosophy, all agree on this point. Low pressure for warming—high pressure for mechanical force.

Steam in its natural, uncompressed state, (212° the same as the highest temperature of water), imparts to the air a mild, healthy, and agreeable heat. Hot water does the same, but is less efficient, and liable to freeze. There is no danger from fire by either of these two modes.

High-pressure steam or water may be dangerous from fire because of the high temperature of its surface. By excessive pressure, they may have some of the unhealthy and dangerous qualities of the hot-air furnace.

The limited amount of fire-surface and heating-sur-

face is a very serious deficiency in al most every heating apparatus of the present day. Where a small surface is required to do a large amount of warming, it must of necessity be heated to a very high temperature. This is done not only at the expense of fuel, but of health. This evil grows out of competition in the trade to get up as cheap an article as possible; but many have found to their sorrow that an apparatus stinted in surface is the dearest one of all. The combustion is imperfect by being too rapid, and a large quantity of fuel escapes and is wasted, which with a slower fire would be burned.

The fuel also has to be often replenished, and a decided loss of heat is incurred by the frequent opening of the furnace door, and the repeated kindling of fresh fuel.

In hot-air furnaces the fire-surface is but the other side of the heating-surface—hence the intense heat that burns up the air, as well as the furnace itself.*

All heating apparatuses, especially those intended for domestic use, should have sufficient heating capacity to allow the fire to burn very gradually—so gradually that it need not, in ordinary weather, be replenished more than twice in twenty-four hours.

It is very important to have the hall, which is the great artery of a house, properly warmed. On the temperature of this—extending as it generally does through all the stories—to a great extent depends the temperature of the whole house. In fact, a house can be tolerably warmed by steam, and at a very small expense, from the hall alone.

A room may be thoroughly ventilated without being at all heated; or it may be thoroughly heated without being in any way ventilated—the latter is too often the case.

* We have seen them so rotten as literally to crumble to pieces by their own weight.

The effective and harmonious operation of the two systems is indispensable, in cold weather, to health and comfort.

In ventilating in connection with heating, a few general rules should be observed. The air should be obtained pure, and retained pure in the process of heating. It should also be evenly distributed while passing into and out of the rooms. The flues that conduct the air in to be warmed should have their external openings from some high point above the line of dust, the products of decayed animal and vegetable matter, and the obnoxious gases which float near the ground. These flues, as well as the ones that take heated air into the rooms, should have sufficient capacity to permit the requisite amount of air to pass through them without creating a rapid current.

Although the cold-air duct should be of sufficient size to supply all the hot-air vents through the building, yet that supply should be varied with the demand. When a part of the warm-air registers are closed, a corresponding amount of air should be excluded from the cold-air duct, as well as from the fire. When the fire goes out, the cold air should be entirely excluded. This arrangement is effected in this steam-heating apparatus, and its advantages are obvious. An equal temperature of the warmed air is maintained, fuel is saved, and freezing avoided.

The surface against which the air is warmed should never exceed the temperature of 250° ; and an ample quantity should be furnished at this limit, to properly warm, in the coldest of weather, all the air that may be required.

We may have the temperature of the heating surface higher without injury, provided, that in no instance, is

the air liable to be confined in contact with it long enough to attain the same degree of heat. But this liability always exists.

Artificially warmed air is generally about 60° below the temperature of the surface from which it is heated. But when it is confined, as in the case of all the registers for its escape being shut, and the fire at the same time unchecked, where the temperature of the heating surface exceeds the above-named limit, not only an unhealthy but a *dangerous* heat is engendered.

The heating surface should never be located contiguous to the fire; it should be several feet remote. This obviates the liability of gas and smoke, incidentally escaping, finding their way into the hot-air chamber. There is also less liability of firing any wood-work that may form a part of the heating or ventilating arrangement.

Each stratum or volume of air, as it floats against a heated surface, is rarefied by imbibing some portion of caloric, and at once ascends, making room for the denser or colder air, which in turn flies from the hot surface, thus creating a circulation that continues until an equilibrium of temperature is established. The rapidity of the circulation depends upon the difference of temperature in the room being warmed and the heating surfaces, when such surfaces are located within the room.

When the heating surfaces are placed within a chamber or chambers of their own, and out-door air is supplied to them, the rapidity of the circulation is proportioned to the temperature of the exterior air, its condition in respect to motion, moisture, etc., and the size length, position, and construction of the ducts for ingress and for egress. Much also depends upon the kind of heating surfaces, their shape, position, and extent; also upon the character of the apartments into which the

warmed air is to be discharged, in relation to outlets, windows, and other condensing objects and exposedness.

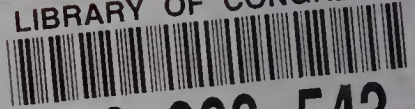
In order to maintain a rapid, reliable, and consistent flow of warmed air, it is requisite that the heating surfaces retain a uniform as well as an efficient temperature against the variableness of the outer atmosphere.

Hot water has neither the power to maintain an even and adequate temperature against severe influences, or to be to any practical extent self controlling. (See page 20.)

Hot-air furnaces, while they have *power to heat*, lack the power to control the fire; consequently, the heating surfaces, whose temperature depends upon the condition of the fire, will get unhealthily, dangerously, and wastefully hot. (See page 15.)

Steam is peculiarly calculated to fulfil these requirements, and is, in fact, the only agent that is capable of accomplishing the desired ends in a warming apparatus. It creates a moderate, agreeable, and, at the same time, a proper *quantity* of heat, while it has, within itself, the necessary mechanical force, which is easily applied, to open and shut the draft to the fire, and thereby control it in exact conformity to the desired conditions of the different parts of the heating and ventilating arrangements. (See page 29.)

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